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INTENSIVE WORK ON RAILWAYS

Attention of electric railway companies has been concentrated more closely in the last few years on the development of existing property than on the extension of lines. The reason for this is found in the main in the underlying business and political conditions and the uncertain attitude of the public toward public utility corporations and securities. We do not mean that development has been discontinued, for many companies have proceeded, notwithstanding the conditions mentioned, to extend their properties. There has been, however, more hestitation about commitments to new enterprises or extensive enlargement of old properties and that hesitancy has led naturally to a more careful investigation into the possibilities of existing systems. Intensive development work of this character offers many opportunities of which managers should gain the full advantage. It enables them to analyze the weak and strong points of the property which, in a period of very rapid enlargement, are in danger of missing that careful separation which is necessary to the best management. Honest introspection shows faults which need to be corrected if the railway is to be operated on a high plane of efficiency, and such research work can be conducted with great profit in many shops.

DESIGNS OF REPAIR SHOPS

There is scarcely room for argument about the necessity for sufficient repair shop facilities. No one who considers the construction of new shops or extension of old shops desires to perpetuate the wastes which accompany the lost motion caused by the interference of workmen with each other on a crowded floor, or the heavy interest charges on "bad-order" cars held out of service awaiting their turn in a shop which is too small to permit them to be overhauled promptly. On the other hand, the futility of an investment in buildings that are two or three times too large for the real needs of the railway is even more obvious. The proper size of a shop for any given set of conditions has, of course, been established in a general way from individual experience, or by comparison with certain existing shops whose condition of crowding or the reverse happens to be known personally to the shop designer. However, the fact that this procedure may be unsatisfactory is demonstrated by a small shop that was planned recently, in which the final design showed a set of buildings more than twice as large as were actually required. This was a case where a designer, in his desire to get the shop large enough, overlooked the fact that by neglecting to be guided by collective past experience of others he was wasting $25,000. Elsewhere in this issue will be found a concrete expression of the past experiences of a number of companies in shop design. A sufficient number of the details agree within reasonably close limits to demonstrate the existence of distinct standards of practice. It is, of course, possible that existing standard practice may be improved later. However, in a matter involving as large an investment as a new repair shop, radical innovations will not be introduced as a rule when the ideas that are generally accepted are expressed in definite form.

THE LOADING OF CARS

One of the tests of careful and economical management of a steam railroad is the average number of tons of freight hauled per train. Those roads which have developed a high average train load have worked toward that end by means of freight cars of large capacity, locomotives of improved types and arrangement of both cars and trains so as to encourage agents and trainmen to attain the desired conditions of good loading. Much less is heard of the average loads of passenger trains on steam roads, because with most companies this portion of their business is so small as compared with the enormous volume of freight hauled that it can almost be regarded as in the nature of a by-product. With electric railways the conditions are so different that the standards of service which are upheld for trunk line operation are discussed only rarely. The difficulty is that the electric railway is required by the nature of its business to furnish a continuous service, without serious variation as a rule for weather, time or season. It cannot hold its cars for full loads. It cannot keep its cars together until a trainload is ready for movement and then begin to furnish the power to move the traffic to destination. It loses the opportunity of loading its cars in both directions because in the morning its traffic is bound to the business center, while in the early evening rush period the movement is all in the reverse direction. Perhaps when the ideal fare arrangement is perfected for electric railways it will provide, as the older type of railroad does, some method of loading the cars in both directions so as to eliminate the present economic waste.

RAIL CORRUGATION ON THE CHICAGO RAILWAYS

Much has been written and many theories have been advanced in explanation of rail corrugations. Everyone will admit, however, that the best basis for arriving at a satisfactory solution of this baffling phenomenon is exhaustive study of the actual conditions under which corrugations appear. In this issue we present an article descriptive of the methods used and data obtained from very close observations made on 20 miles of double track on the Chicago City Railway and 85 miles of double track on the Chicago Railways. The observations were not taken with a view to eliminating the cause of corrugations, but to locate the worst ones, so that the engineers could direct the rail-grinding crew where the rail needed immediate attention in order to reduce vibration in the cars. As an evidence of the accuracy used in taking measurements the depths of the corrugations were read on the Chicago City Railway tracks to 0.004 in., and it required about three and one-half months for the investigating crew to cover the territory. The care with which the notes were made, recording the depth, wave length and location of the worst corrugated spots, is evidenced when one inspects a page taken from a large volume of notes.

An examination of the tables presented develops some interesting things relative to the locations of the worst corrugations. It was found that the maximum percentage and depth occur on Cottage Grove Avenue, where the foundations are the most rigid, where the traffic is densest and where the cars are operated at the highest speed. When the Cottage Grove line was electrified, the old cable way was filled with concrete. Thus the concrete foundation under this track is more than 3 ft. deep, and to make the construction more rigid steel ties were used, spaced at 3-ft. intervals. The minimum percentage and depth of corrugation occurred on Eighteenth Street on a less rigid foundation and where the speed of the traffic was slow and wooden ties were used. It is also interesting to note that the wave length approximates 3½ in., and that the length increases with the depth of the corrugation. Some other points developing from a careful study of the detailed notes are that corrugations always appear and are deeper and larger on loose rails. Corrugations were always found on the outside rail on high-speed curves, at the foot of steep grades and in many cases on approaches to sharp curves. Further inspection of the detailed notes also shows that corrugations do not occur at any particular point in a block but seem to be worst about the middle, where the speed is the greatest.

We hope that the elaborate data secured in Chicago will be of some assistance to those who are sanguine about determining the cause of rail corrugation. In the meantime the problem in Chicago, as elsewhere, resolves itself into one of devising the cheapest method of removing corrugations when their frequency and depth are sufficient materially to increase the equipment maintenance.

BRAKESHOES AND WHEEL WEAR

The abstract of an elaborate report on brakeshoes made to the Brooklyn Rapid Transit Company by George L. Fowler and printed in another column deserves close attention, not only because of the care and thoroughness with which the investigation was made but also because of the new points which have been brought out in the report. Thus it is perhaps a little unexpected to find the statement made that the coefficient of friction of brakeshoes is a negligible factor within the limits of their use upon street railways, yet the proposition is quite reasonable when we consider the low speeds and dirty rails that are the principal elements in the work. Again, the suggestion comes as a surprise that foundries try to get homogeneous material and a balanced carbon content in order that the best results in economy of operation may be secured. Here we have an interesting check. Mr. Fowler reached his conclusions from the car and operating end of the line by watching shoes at work and tabulating results. Quite unaware of Mr. Fowler's work and wholly ignorant of his deductions, a skilled foundryman who had been making brakeshoes for years said the other day that his whole experience in the business led to the belief that best results would be obtained by a balancing of the carbon content of the shoe, or the same conclusion was reached by starting at the other end of the line, the cupola. Neither of these gentlemen, however, would advocate a specification calling for such a thing. It is merely a goal to reach if possible.

But the most important feature of the report is the difference that exists in the wheel wear under different shoes. Of course, to secure friction in braking there must be a certain amount of wear on one or both of the surfaces in contact. Usually the primary purpose in the selection of a brakeshoe, after the question of braking efficiency has been

determined, has been to secure long life. Mr. Fowler deserves great credit, first, for bringing out clearly the fact that wheel wear must not be neglected in any consideration of brakeshoe cost, and, second, for determining the exact amount of wheel wear from the different types of shoes tested.

The economic importance of this wear of wheels will vary, of course, with the portion of the wheel worn. If the wear from the brakeshoe is on those areas of the wheel which are also subject to wear by the rail, the periods between turnings are shortened and the wear is expensive, but if the wear is on those parts which would have to be removed by the turning tool when the wheel is shopped, the brakeshoe wear is not a serious item. The test in Brooklyn was made with steel wheels. Probably the same conditions will not hold for cast-iron wheels, because the brakeshoe wear on the face of a chilled wheel is undoubtedly much less than on a steel wheel.

The report, as it stands, is probably the most comprehensive and complete that has yet been prepared by any railway on the subject of brakeshoes. It merely touches on the use of brakes and the stopping powers of various riggings. This is, however, now the subject of a special inquiry by the same engineer, regarding which we hope to publish the data in a future issue.

PAYMENT FOR REPAIR SHOP LABOR

The portion of the total operating expense of the average electric railway which is comprised in the labor cost of repairing cars is not a large percentage of the whole. It becomes a formidable item, however, when operating expenses are heavy and especially when the margin remaining from gross earnings for profit is small. On some fortunate roads a reduction of 30 per cent in the shop payroll would scarcely be felt, but in most cases the saving would be well worth an effort. A discussion predicated on a reduction of one-third in the cost of repairs may appear fantastic, but the experience in the shops of the Interborough Rapid Transit Company is evidence that the figure given is actually a conservative estimate of what was done by the discontinuance of the customary day-work payment plan.

Of improved methods for paying labor, such piece-work and bonus systems as are used in the Interborough shops and described in another part of this issue are probably the best known. In addition to these there are the much advertised "standard time" of the efficiency engineer, together with a host of profit-sharing, sliding wage scale schemes which are adaptable to, and successful under, special conditions.

Under analysis the three best known systems for payment differ mainly in their treatment of increased output. The day-work plan, for instance, allows nothing for an increased number of pieces; the bonus plan allows for a fraction of them, and the piece-work plan pays for all. Manifestly the two former should not apply to strictly manufacturing enterprises where a large output per man is so vital to economical shop operations. This is emphasized in several manufacturing plants where, in order to put a double premium on high individual output, payments are made by the piece with an increase in the price per piece for everything turned out in excess of the normal. In electric railway shops the difficulty with piece work lies in the necessity for overcoming what might be called "inertia" of the shop force. Correct piece prices may sometimes be one-half or one-third of the day-work costs. If piece prices are made properly, there will be such a reduction from the cost existing under day work that great effort and unlimited patience will be required to develop the work to the point where the workmen begin to get some advantage in larger wages. In many cases the number of jobs of one kind is not large enough to warrant this effort.

With the bonus system, however, considerably less attention is required. It is much more flexible than piece work and can be made almost automatic in action. It is not necessary to split the savings equally between the men and the company as described in the article on the Interborough practices, although the absolute minimum costs are obtained by following that method. The savings under the normal cost, or "list price," can be divided one-quarter to the men and three-quarters to the company and the "list price" made the same as the day-work cost. This permits the workman to get an advantage at once from increased output, and a constantly increasing wage as his output increases. If the list price is set at the cost under day work, such a division produces the following results: For an increase in output of 50 per cent, the decrease in cost to the company is 25 per cent and the increase in pay for the workman is 12½ per cent. For 100 per cent increase in output the two figures are 37½ per cent and 25 per cent. For 200 per cent increase in output the increase in pay and the saving in cost are 50 per cent. If the saving is divided evenly between the men and the company and an increase of 200 per cent of the output should be obtained, the cost is decreased only one-third while the workman's pay is doubled. This demonstrates the fact that under the method of dividing savings equally the list prices must be made low, in fact, close to the proper piece price for the work. This is the same general objection that applies to piece work. It takes time and expense to determine the proper price for any job, and it takes more time to develop the work to a point where a man begins to be encouraged by receiving higher wages. When this point is reached, however, the maximum results are obtained; the men are earning increased wages, and the employer is having his work done at a lower cost, so both profit.

Of course, no improved system of payment will produce satisfactory results unless the size of the shop force is changed rigidly in inverse proportion to the increased output per man. For instance, if the one job of turning wheels is put on piece work or bonus, and the daily output of the men doing that work is doubled, the shop force must be reorganized and reduced by one man if any effect is to be shown on the payroll. It is this difficulty that makes many piece-work systems a failure. Sometimes piece work and day work are mixed together. One man works hard and gets extra pay. The extra work which he does is taken away from the rest of the men in the shop, and it is likely to be divided up among them so evenly that apparently no one does any less work. The net result, therefore, is an actual increase in the payroll without any increase in the total work done.

CORRECT CAR MAINTENANCE BY THE SMALL COMPANY

Mr. Crouse's paper on "The Maintenance of Electric Railway Equipment," which is printed on another page, is in accord with the general subject of this issue. It is mainly a sane exposition of the saying "Prevention is better than cure," as applied directly to the upkeep of car equipment. Any one who has observed conditions on a large number of the smaller isolated properties must confirm Mr. Crouse's statements with regard to the unfortunate acceptance of conditions which some of their officials show, first, in allowing their equipment to stay on the line until it breaks down in service and, second, in confining the shop work only to the parts which have been damaged visibly. Despite the remarkable advances which have been made from time to time in design and construction, motors will always have parts to wear and deteriorate, and that fact cannot be ignored. Those who pursue the practice of makeshift repairs instead of periodical inspection and overhauling delude themselves into the belief that they are actually effecting economies. As a matter of fact, a large portion of the maintenance cost, namely, the service loss of the car, does not appear in any charges for material and labor, but it is nevertheless a very important item. The effectiveness of car maintenance might well be gaged by a defect record of individual cars which would show whether the previous repair job was a real rehabilitation or mere tinkering.

Mr. Crouse has not confined his paper to generalities, but on the contrary has given definite suggestions as to what should be done to almost every part of the electrical and mechanical equipment during both inspection and overhauling. It is clear, however, that his program requires a master mechanic who is capable as well as conscientious. Unfortunately, the salary which the small company is able or willing to pay for a master mechanic is often no more than can be earned by a good machinist or carpenter who has no executive responsibilities. Consequently, such positions are often taken by those who introduce to the electric railway shop the rough and ready methods with which they are familiar. The truth is that the maintenance of car equipment, with its wide variety of both rough and refined work, is a real business which is entitled to the services of a well-paid, all-around man who combines at least the rudiments of a technical education with his ability as a craftsman. As an example, his knowledge about brake rigging should be such as to enable him both to calculate the most suitable leverages and to direct his blacksmith how best to repair a broken rod.

A valuable suggestion made by Mr. Crouse is that technical graduates should be employed to supplement the work of the master mechanic by making statistical and analytical studies of car operation, standardization, etc. No doubt, this kind of work would be more to the taste of most college men than a long, discouraging course in the pit or at the armature stand. The aid of such trained men should be welcomed, especially by those master mechanics who find the keeping of statistics so distasteful that they are inclined to deny altogether the value of analytical records.

TRACK FOUNDATION UNDER PAVEMENTS

The selection of the type of track foundation under city streets which will give the best service at a minimum expenditure is a problem which confronts engineers when they prepare for the reconstruction of existing lines or for new extensions. There appears to be a general tendency to use concrete almost exclusively for this purpose. Careful investigations made recently on the surface railways in Chicago, however, have shown that similar results may be obtained by using a compactly rolled or tamped crushed stone or gravel. A study of the advantages and disadvantages of both types affords a comparison that is instructive.

When concrete is employed as a track foundation the accepted practice has been to make the depth 6 in. under the ties. On new work little difficulty is experienced in obtaining first-class concrete foundations; the track is laid and blocked to a proper elevation and the concrete foundation deposited in place and allowed to set perfectly before it is necessary to turn traffic over it. In the reconstruction of old track the results are not so satisfactory unless it is possible to route traffic around the piece of newly laid track; in fact, in many cases the foundations are not permitted to set sufficiently before cars are operated.

Investigations as to the proper length of time to allow for the setting of concrete foundations have shown that it should be not less than ten days and experience on the Chicago railways has extended it to fourteen days. In many cases the failure to allow sufficient time has resulted in crushing the green concrete, causing the track to become badly out of line and surface. It has been learned that the best results are obtained by spacing the ties, whether steel or wood, at 3-ft. centers. The general opinion has been that concrete provided additional bearing. It has been found, however, that dependence upon the concrete bearing value has led to increased tie spacing to such an extent as to break down the foundation.

The use of crushed stone or gravel instead of concrete for foundations offers little advantage from the standpoint of initial cost for new work. However, in the reconstruction of old track, the use of one of these materials may be advantageous for several reasons. Although it may be necessary to increase the depth of the foundation 1 in. or 2 in., the cost of the material in place is lower, and the setting time is eliminated. In fact, the best results are obtained if traffic is turned over the track immediately after it is raised to the finished elevation. This reveals the weak points and permits retamping before the paving is laid.

The fact that ties must be spaced at closer intervals on crushed stone than on a concrete foundation has influenced the popularity of the latter type. The result of the tests on the Chicago railways shows that spacing should be decreased to 2 ft. intervals for either wood or steel ties. The reduced cost of material and labor with crushed stone as compared with concrete, however, more than offsets the increased cost of ties. As to the relative life of the tie in crushed stone or in concrete foundations, experience has shown that there is practically no difference. A factor which does not appear to receive proper weight is the reduced maintenance cost resulting from the use of crushed stone.

While the use of concrete is absolutely necessary in some

instances, particularly where the subsoil is composed of quicksand or boggy material, these cases are special. Where the subsoil has good bearing qualities crushed stone may be used so as to secure increased flexibility and decreased maintenance cost. Another point for consideration is the result of increased rigidity where that exists in track construction. The more rigid construction is believed to increase rail corrugations and therefore to decrease the life of the rail. The cost of rail grinding is also a factor.

During the reconstruction of old track, the problem of routing cars is a serious one, especially during rush hours, on many railways. As it is essential to a good concrete foundation to keep the track affected out of service for at least ten days, the cost and inconvenience of the delays experienced in routing traffic around new work should be considered.

Since the cost of material and labor in the construction of a concrete foundation is about the same as for crushed stone and the life of both types is about the same, provided equal diligence is employed during the construction period, the matter should be considered from the standpoint of operating cost. The increased facility for making repairs and the probable reduction of rail corrugations, which affect the cost of maintaining the equipment if they are serious, are worthy of thought. When the question of foundation is not governed by the bearing quality of the subgrade, it appears that crushed rock or gravel has many advantages under the conditions prevailing in Chicago.

THE NATURE OF MAINTENANCE

The policy adopted by an electric railway company in regard to the maintenance of its physical property is a vital influence in the financial outcome of its operations. It is also an influential factor in the answer to the question of whether or not the company meets successfully the exacting demands of the public for service. It is with the purpose of describing maintenance methods of companies located in various sections of the country and operating systems of different mileage that the annual maintenance number of the Electric Railway Journal is published.

What a company does with respect to maintenance is important in three ways. The first noticeable effect is in operating expenses. The avowed purpose of operating expenses is to include not merely the cost of current repairs and small renewals, but all the other costs of upkeep of the property. The ill results of a policy contrary to this are plain in the end if not in the beginning. The proportion of the gross revenue which is not required for operating expenses and taxes is available, first, for fixed charges and then for dividends on the stock. If the operating expenses are reduced by normal means, the amount of net income is increased; or to charge to operating expenses less than the amount that is required normally to provide for the upkeep of the property increases the apparent net earnings. The eventual result of a policy which fails to provide for the upkeep of the property is realized sooner or later in excessive physical deterioration and in unduly large expenditures which must be incurred to offset the earlier failure to maintain the property properly at all times.

While one effect of a prolonged unsatisfactory policy in the treatment of maintenance is eventual heavy charges to operating expense accounts, another, if the policy extends still further unwisely, may be to add to the capital account those expenditures for reconstruction or rehabilitation which are designed to restore property uncared for through operating accounts. Some leeway, however, in the time of expenditure is necessary even though all the expenditures are charged to operating expenses. A degree of safety and protection should be assured. Since electric railways are affected to some extent by business depression, though not to the same degree as companies engaged in most other forms of business, they can prudently restrict their maintenance expenditures in a year of declining revenue and increase them in years of expanding revenues. With a reasonable policy of this nature no fault can be found. It is what prudent business men do everywhere. Moreover, if there is capital resource or borrowing capacity in years of depression over that which is reasonably needed, it may be used to effect a saving by the purchase of certain materials which are quoted at low prices because of the temporarily reduced demand. It is the policy of long-deferred maintenance which is not only a form of unwisdom but is in reality a useless and an expensive form of luxury. Maintenance expenditures that are long deferred have an uncurable faculty of increasing in proportion as they are deferred.

A third effect of an unwise policy in maintenance which should receive careful attention is the result upon the public in the community served. While the traveling public likes new cars, it is not practicable or economical for every car to be new. It is practicable, however, for equipment and tracks to be in more than reasonably good condition; in short, to be in such shape as to invite travel. It is also in the business interest of the companies to keep their rolling stock clean and thus to invite travel and encourage a current of favorable comment which will do much to settle some of the problems with which the industry has been confronted.

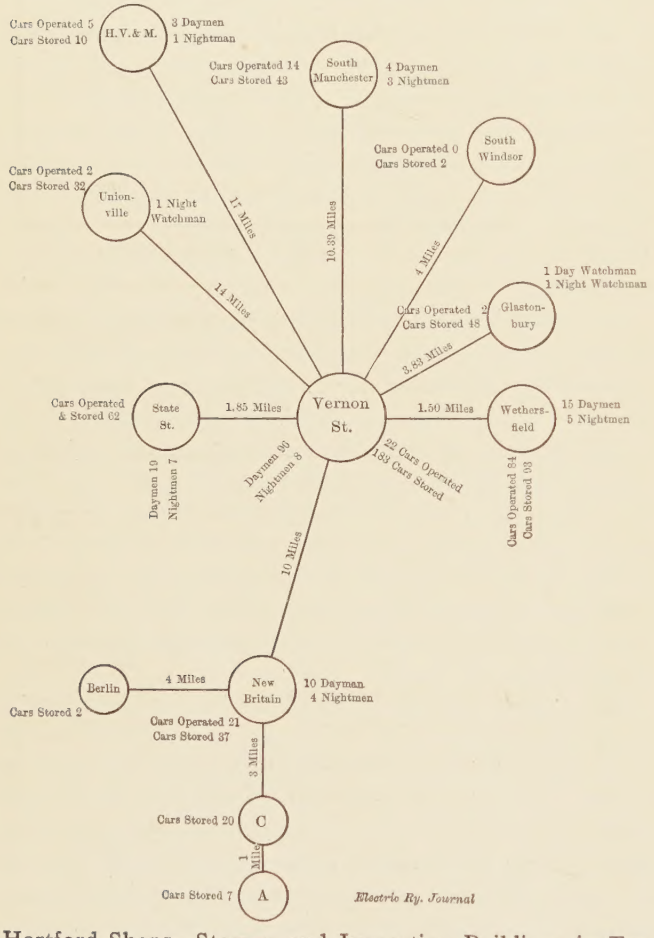
The material published in the following pages necessarily treats very largely of the details of the methods followed. Such details, it is true, are framed pretty much because of a definite principle or policy of maintenance that is laid down by the management as a guide for the mechanical officials. Yet the details of the quality of work found in the shops of electric railway companies are sometimes very different in principle from the fundamental policy of maintenance which the management has determined to follow. That is to say, the management may have elected to follow a policy as to maintenance that is essentially unsound, while, in spite of that fact, the mechanical officials develop methods that are so efficient as to effect results which are the exact reverse of those that would naturally be expected. On the other hand, it is sometimes the desire of a management to maintain its property well, so as to permit good service to be rendered at all times, but the mechanical officials adopt lax methods that nullify the spirit of this intent. The wise policy of maintenance combines a rigid and wholesome executive program with co-operative effort and determination on the part of the mechanical officials and their working forces.

Shop Notes from Hartford, Conn.

Effective Car Maintenance Practices and Labor-Saving Methods at One of the Most Important Shops of the Connecticut Company

Among the most important car maintenance centers of the system of the Connecticut Company are the Vernon Street shops at Hartford. The buildings at this installation are no longer of a character desirable for the maintenance of modern cars, and, in fact, plans have been made for their reconstruction and enlargement pending the approval by the city of the necessary special-work layouts. For all that, the handicap imposed by cramped quarters has not prevented the shop management from devising inspection, repair and record practices which may be found worthy of adoption elsewhere.

The territory now tributary to the Vernon Street Shops is indicated on the accompanying diagram, which shows



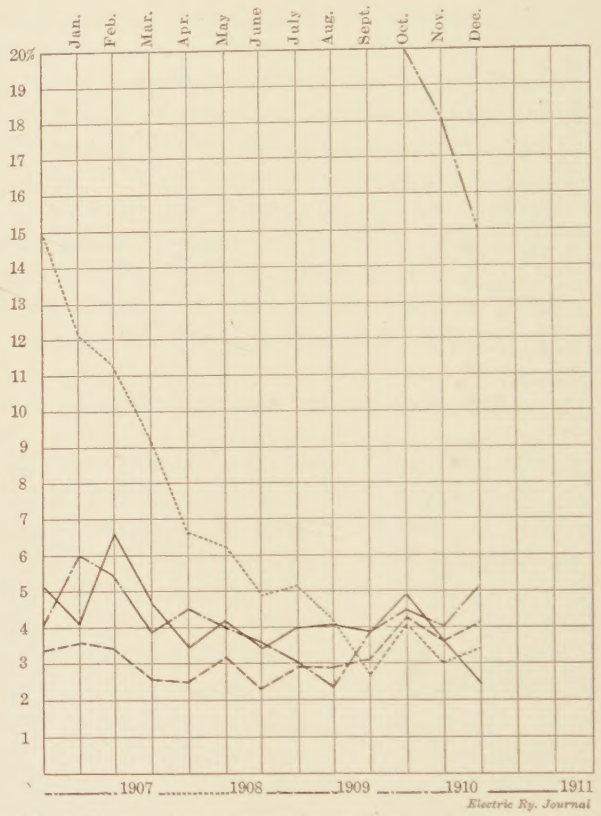
Hartford Shops—Storage and Inspection Buildings in Territory of Hartford Shops

the number, car capacity and distance from the shops of all operating storage carhouses on the Hartford and New Britain divisions. The most distant carhouse is 17 miles from Hartford. The New Britain group, which is 10 miles to 14 miles distant, was recently added in order to concentrate more maintenance work at the Hartford shops. The combined storage capacity of the structures indicated on the drawing is 539 cars, of which number 212 were in operation Dec. 13, 1911.

A rather interesting feature of the diagram is the set of figures showing the comparative number of men employed for night and day work respectively at the different places. The tendency toward day inspection is clearly shown by the condition that the subsidiary carhouses employed a total of fifty-one day men as compared with twenty night men, exclusive of the watchmen. At the shops themselves there were ninety-six day men and eight night men.

CAR RELIABILITY RECORDS

The important results which day inspection has helped to accomplish since its adoption four or five years ago are demonstrated by the accompanying curves, which show that since October, 1907, the percentage of crippled cars has been reduced from 20 to 4. Curves are also kept to show the number of crippled cars per 10,000 car miles, crippled cars per month and of all cars operated per month. In addition to these curves, others are made for each kind of car trouble from the annual summaries of all troubles at the several carhouses. Graphical comparisons between different car-



Hartford Shops—Percentage by Months of Cars Pulled in to Number of Cars Operated

houses are also made. All reliability-of-service curves mentioned are based on monthly tabulations of car defects similar to that for December, 1911, which is reproduced on the next page. It will be noted that this defect list goes beyond the ordinary mechanical and electrical troubles, as it includes dirty cars, broken windows and the like. In fact, this form is intended to cover any occurrence which makes it desirable to return the car to the shop. The list of troubles for December, 1911, shows that out of 4719 cars operated only 137 cars had to be changed. The car miles run were 626,078, and the change per 1000 car miles was 0.218. A study of the ca[illegible]s by groups shows the following proportions of the whole: motor troubles, 35.54 per cent; car wiring, controller, fuse and fuse and circuit breaker troubles, 11.3 per cent; compressor troubles, 9.48 per cent.

A remarkable feature which indicates the careful inspection of the equipment is that there were only two hot armature bearings during the entire month. The list also shows that 10.21 per cent of cars reported defective were

actually in satisfactory condition and that 0.63 per cent of all cases reported were for causes not chargeable to the mechanical department.

For convenience in reproduction, only the totals of all three maintenance centers have been given, but in its complete form this report offers a ready comparison of the several carhouses in this territory.

THE CONNECTICUT COMPANY.—MONTHLY STATEMENT OF CARS PULLED IN ON HARTFORD DIVISION, DECEMBER, 1911

Location of Trouble	Total Number	Per Cent
Armature	32	23.15
Armature bands	..	..
Commutator	..	..
Brushholder and yoke	4	2.92
Brush spring	7	5.10
Brushes	..	..
Fields	6	4.37
Motor leads	..	..
Motor suspension	..	..
Pinion	..	..
Gear	..	..
Gear case	..	..
Hot armature bearing	..	..
Compressor armature	3	2.19
Compressor field	..	..
Compressor brushes	3	2.19
Governor	7	5.10
Air pipe	..	..
Air valve	..	..
Miscellaneous air	..	..
Car wiring	1	.73
Controller	11	7.65
Circuit breaker	3	2.19
Switches	..	..
Fuses	1	.73
Resistance	..	..
Headlight	3	2.19
Lamps burnt out	..	..
Heaters	1	.73
Miscellaneous electric	..	..
Trolley pole and base	2	1.46
Trolley wheel	..	..
Car struck by lightning	..	..
Trucks	..	..
Broken journal box	..	..
Hot journal	2	1.46
Broken spring	..	..
Loose wheel	..	..
Broken flange	..	..
Brakes	..	..
Brake chain	..	..
Broken brake hanger	1	.73
Broken brake rod	1	.73
Broken brake bolts and pins	..	..
Broken brakeshoes	2	1.46
Loose tire	..	..
Register equipment	1	.73
Seats	1	.73
Doors	..	..
Side bar and rope	..	..
Curtains	..	..
Signs	..	..
Sandbox	..	..
Scrapers	..	..
Foot gong	..	..
Dirty car	..	..
Miscellaneous mechanical	15	11.94
Broken axle	1	.73
Sprung axle	1	.73
Flat wheel	..	..
Damaged car body	..	..
Windows	4	2.92
Broken grab handles	..	..
Broken running board and step	2	1.46
Broken fender	8	5.80
Trolley base pulled off	..	..
Dirty car—fault of passenger	..	..
Reported but found OK.	14	10.21
Split a switch	..	..
Off track	..	..
Total number of cars operated	4,719	..
Total number of cars changed	137	..
Per cent of changed to schedule	..	2.90
Per cent not chargeable to mechanical department	30	.63
Per cent chargeable to mechanical department	107	2.27
Total car mileage	626,078	..
Change per 1000 car miles	0.218	..

Hartford Shops—Condensed Monthly Statement of Car Pull-ins and Their Causes

RECORD FORMS

The primary form of the defect record system is the car replacement report, reproduced on this page, which includes time and place, the motorman's report and the shopman's account of the repairs made. These reports are assembled for the daily car failure statement, which is made out according to carhouses, as shown in the accompanying tabulation of troubles for Jan. 21, 1912. The elimination of defects which lead to hot bearings is considered so important that a special report must be made to cover each case of bearing trouble. Armature bands, for instance, are torn off from such causes as dirt or water in the oil cup, worn-out dowel pins, caps lost off the end of the bearing, use of summer oil in cold weather, glazing of waste by dirt, etc.

Among several other forms used for inspection, there are two on which reports are made to the local manager to state the progress through the shop of overhauled open and closed cars respectively. The report for closed cars is substantially like the one on open cars, as reproduced herewith, except that it includes scrapers, heaters and other winter equipment.

INSTRUCTION PRINTS

Several hundred shop instruction prints, 10 in. x 7¼ in. in size, have been prepared to cover standardized methods

CARS PULLED IN THIS DAY FOR FAILURE OF EQUIPMENT.

STATE STREET Jan. 21, 1912

Car No	Taken Off	Motorman Number	Line	Trouble.
471	12:30 p.m.	2789	West Hartford	Reported for blown breaker; found same OK.
			WETHERSFELD	
506	5:15 p.m.	2911	Blue Hills	Sign out of order.
489	5:07 p.m.	2845	Wethersfield	Resistance wire burnt off.
			VERNON STREET	
408	4:52 p.m.	....	New Britain	Grounded armature.
			MANCHESTER	
25	6:30 p.m.	3129	Crosstown	Brush spring burnt off.
			H. V. & M. O. K.	

Total, 5 cars.

.....
Superintendent of Shops.

Hartford Shops—Type of Daily Pull-in Record

REPORT OF PROGRESS IN OVERHAULING OPEN PASSENGER CARS.

Week Ending.....1912

DOUBLE TRUCK

Trucks	Motors	Body	Fenders	Light Circuit	Signal Light	Air Brakes	Control.	Trolley	Resist.	Circuit Breaker	Painted

SINGLE TRUCK

Trucks	Motors	Body	Fenders	Light Circuit	Signal Light	Control.	Trolley	Resist.	Painted

Electric Ry. Journal

Total D.T.
Total S.T.
Total

.....Supt. of Shops

Hartford Shops—Car Progress Report for Manager

THE CONNECTICUT COMPANY

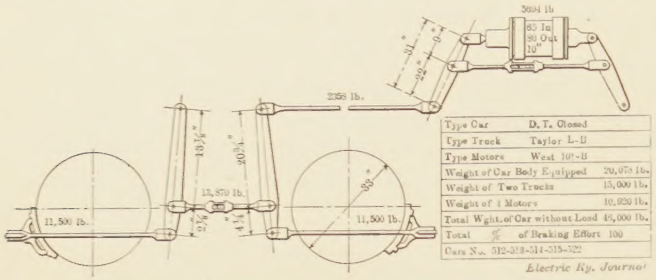
CAR REPLACEMENT REPORT

Division, *Hartford.* Date, *Dec.* 18, 1911.
Car No. 137 was taken off *Burnside* line at 7.37 p. m., and replaced by Car No. 133 at 7.37 p. m.
Motorman No. 3011.
Trouble was reported by *Walsh* as *motor trouble.*
Trouble found and repairs made as below:
Motor lead burnt off.
.....
Repaired and reported to carhouse foreman as ready for service
..... at.....m.
State Street Carhouse. *W. E. Crilly,* Foreman.

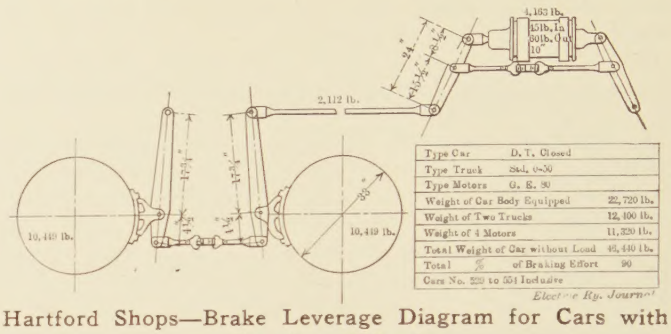
Hartford Shops—Car Replacement Report

of motor connections and brush arrangements, similar to the diagrams which have been reproduced in these columns from time to time in describing the practices of the Public Service Railway, Brooklyn Rapid Transit System and United Railways & Electric Company of Baltimore. In addition to these prints of electrical nature, brake leverage layouts have been prepared to cover every style of car that goes through the shops. As shown in two of the accompanying diagrams for cast-iron and steel-wheel equipments respectively, each sheet is intended to indicate the type of car, trucks, motor equipments, weights of car body, trucks and motor, total weight without load, total percentage of

braking effort and the numbers of all cars in the specified class. These brake leverage diagrams are supplemented by the braking studies sheet shown on this page which offers a convenient means to determine accurately the best leverage arrangements and choice of air-brake cylinder sizes for given air pressures. It will be observed that this sheet in-


5684 lb.
2268 lb.
13,870 lb.
11,500 lb.
11,500 lb.
Type Car D. T. Closed
Type Truck Taylor L-B
Type Motors West 107-B
Weight of Car Body Equipped 20,975 lb.
Weight of Two Trucks 15,000 lb.
Weight of 4 Motors 10,025 lb.
Total Wght. of Car without Load 45,000 lb.
Total % of Braking Effort 100
Cars Nos. 512-513-514-515-522
Electric Ry. Journal

Hartford Shops—Brake Leverage Diagram for Cars with Steel Wheels


4,163 lb.
2,112 lb.
10,449 lb.
10,449 lb.
Type Car D. T. Closed
Type Truck Std. O-50
Type Motors G. E. 80
Weight of Car Body Equipped 22,720 lb.
Weight of Two Trucks 12,100 lb.
Weight of 4 Motors 11,320 lb.
Total Weight of Car without Load 46,140 lb.
Total % of Braking Effort 90
Cars No. 229 to 551 Inclusive
Electric Ry. Journal

Hartford Shops—Brake Leverage Diagram for Cars with Cast-Iron Wheels

cludes the area of 7-in., 8-in. and 10-in. cyclinders, which are the present standard sizes on this system. The dimensions of the auxiliary reservoirs required in each case are also given.

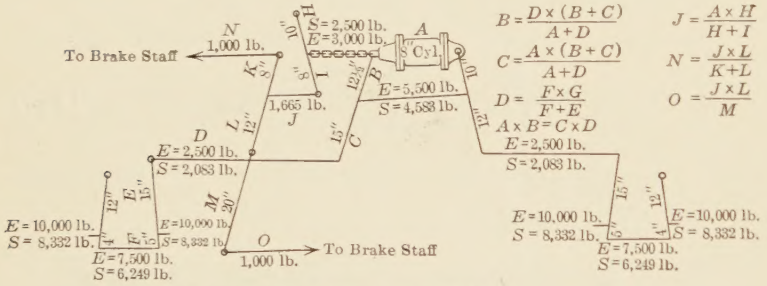
The utility of these braking sheets is readily apparent in those instances when the motorman turns in a car for poor braking. Leverage measurements are made, the air pressure is determined and the dimensions of the cylinder are taken. From his instruction sheet covering the car under examination the shop superintendent can soon determine the braking pressure and leverage distances required to give the proper braking effort for the service. A braking effort of 100 per cent is held to be permissible for steel wheels, but no more than 90 per cent is used for cast-iron wheels in order to minimize the generation of flat spots.

Prints of brakeshoe heads are also used as guides for ordering designs which are in conformity with the standards of the American Electric Railway Engineering Association. At one time the lines embraced by the Hartford and New Britain divisions used from fifty to sixty brakeshoe heads. The present number is twenty-four, but within a short time only five brakeshoe heads will serve for all cars in regular daily service.

The motor data sheet produced on page 535 is uniform with the several kinds of instruction prints already mentioned. This table, which was checked by the motor manufacturers, not only presents the usual data in regard to capacities, weights and gearing, but also includes statistics of special value in the shop, such as the number of coils in the armature, the number of armature bars, the throw of the coils, the original and safe wearing diameters of the commutator, the number of turns in the field and the size of wire.

LUBRICATION IMPROVEMENTS

A perplexing problem for the users of the old grease-cup motors is to adapt them for proper oil lubrication. The Hartford shops have accomplished this desirable change on GE-800 motors by using the oxy-acetylene welding process for closing the bottom of the large grease openings in the armature and axle bearings. After the welding was completed a hole was drilled in the bottom for the insertion of a wick which is soaked with oil. This method gives far better lubrication than was formerly obtained by using grease and felt. Another unusual feature of this company's lubrication practice is that the day's supply of car oils is kept in the shops in a metal-lined box, which during cold weather is heated by a bank of incandescent lamps attached to the cover.


To Brake Staff
N
1,000 lb.
S = 2,500 lb.
E = 3,000 lb.
A
Cyl.
1,665 lb.
J
E = 5,500 lb.
S = 4,588 lb.
D
E = 2,500 lb.
S = 2,083 lb.
C
A x B = C x D
E = 2,500 lb.
S = 2,083 lb.
E = 10,000 lb.
S = 8,332 lb.
E = 10,000 lb.
S = 8,332 lb.
E = 10,000 lb.
S = 8,332 lb.
E = 10,000 lb.
S = 8,332 lb.
E = 7,500 lb.
S = 6,249 lb.
E = 7,500 lb.
S = 6,249 lb.
O
1,000 lb.
To Brake Staff
B = D x (B + C) / A + D
C = A x (B + C) / A + D
D = F x G / F + E
J = A x H / H + I
N = J x L / K + L
O = J x L / M

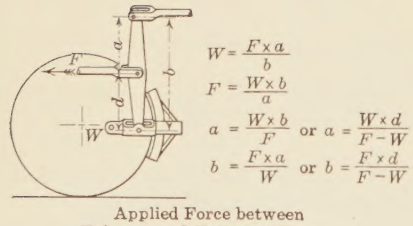
Light Weight of Motor Car, 40,000 lb.
Braking Power, 40,000 lb or 100 per-cent.
E indicates Forces in Emergency Applications and
S indicates Forces in Full Service Applications.

The following table gives the forces exerted upon the pistons of the different sized cylinders with pressures of 50 lb., 60 lb. and 70 lb. per sq. in.

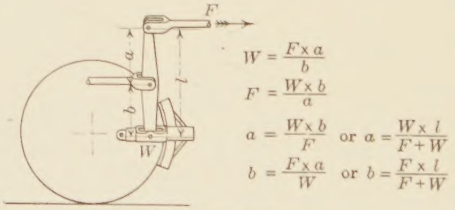
Size of Cylinder	16"	14"	12"	10"	8"	7"
Area of Cylinders				78.54 sq. in.	50.27 sq. in.	38.48 sq. in.
50 lb Pressure	10,050	7,700	5,650	4,000	2,500	1,950
60 lb. Pressure	12,050	9,200	6,700	4,700	3,000	2,300
70 lb. Pressure	14,100	11,800	7,900	5,500	3,500	2,700

AUXILIARY RESERVOIRS USED WITH DIFFERENT SIZES OF BRAKE CYLINDERS.

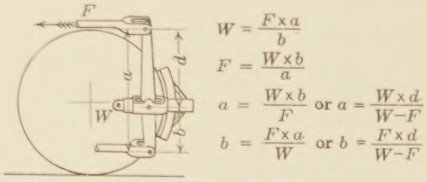
10" x 33"	Auxiliary Reservoirs with	8"	Brake Cylinder of all kinds						
12" x 33"	"	"	"	10"	"	"	"	"	"
14" x 33"	"	"	"	12"	"	"	"	"	"
16" x 33"	"	"	"	14"	"	"	"	"	"
16" x 42"	"	"	"	16"	"	"	"	"	"



Applied Force between Fulcrum and Delivered Force.



Fulcrum between Applied and Delivered Forces.



Delivered Forces between Fulcrum and Applied Force.

Electric Ry. Journal

Hartford Shops—Study of Braking Pressures

LABOR SAVING IN SHOP MOVEMENTS

The halftone on the next page shows a hoist which was built for handling wheels or wheel sets in the yard. This rigging consists of a steel trolley pole, a boom made of old rail and an ordinary air hoist of 1800-lb. capacity. The boom has a clear swing of 25 ft., which is ample to handle wheels to and from the longest flat cars operated in this

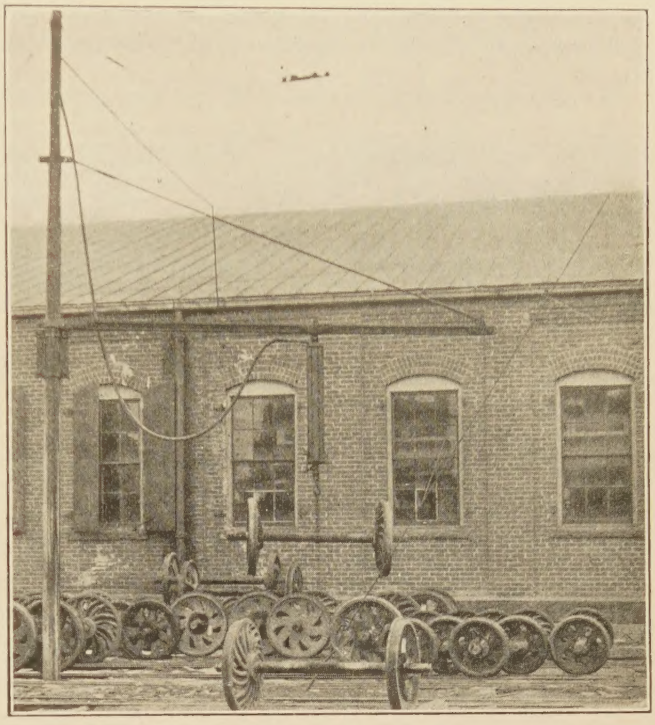
yard. An illustration on page 536 shows a 3000-lb. motor-operated Yale & Towne chain hoist which serves the machine shop and armature room. This hoist is connected to the bottom of a former compressor motor, which retains its original gearing. The operations are conducted by means of three handles which are suspended from the motor as shown. The "up" and "down" handles are attached to the opposite ends of a pivoted wooden strip which bridges the circuit contacts. Springs are provided to return the strip to the neutral position. The third handle is used to operate the brake. Current is supplied to the motor through a shoe of copper strap which makes contact with a ¾-in. T-section conductor carried in a trough which was built alongside the hoist runway.

MOTOR PRACTICES

Several types of motors, including the Westinghouse 12A, 93A and 101B, have pressed-in bearings. Formerly these bearings were replaced by using a sledge hammer, but the latter practice has been discontinued as it sometimes caused the breakage of the bearings. The bearings are now removed and replaced by the aid of a home-made air press which consists principally of an old car cylinder, the frame of a Westinghouse No. 49 field press upon which the cylinder is mounted, a gage, valve handle and the necessary piping. Air at 70 lb. to 90 lb. pressure is available for this service, but it has been found that for general purposes a 16-in. cylinder should be used in place of the present 10-in. cylinder. In operating this press metal blocks, rings and even trolley wheels are used between the bearings and the piston to insure uniform distribution of pressure. This air press is also used for inserting bushings in compressor motor bearings and for similar work.

Cutters which are graded to 1/64 in. are used to insure the absolutely correct diameter of finished armature and axle bearings when the bearing is being centered in the lathe. Other cutters are used to finish the face of the bearing at the same time.

The oxy-acetylene welding system is also used for repairing pinion-end breakage of AA-4 compressor armature shafts. The shaft is cut off for some distance beyond the break and then bored to a depth of ½ in. to ¾ in. for align-



Hartford Shops—Yard Hoist for Wheels and Axles

Motor	Hp.	Wght. with Gear and Gear Case	Max. Diam. of Axle	Clearance Above Rail 33-in. Wheel		Sum of Gear and Pinion	Gear Ratio			No. Coils in Armature	No. Com. Bars	Throw of Coils	Orig'l Com. Diam.	Safe Wearing Diam.	No. Turn in Field	Size of Wire	Weight of Equipment	
				Motor	Gear Case		Stand	Min.	Max.								Two Motors	Four Motors
G.E.-1200	38	2900	4	...	...	77	17.60	17.60	27 50	105	105	1–27	8½	7⅞	270	No. 6	7000	14,200
G.E.-1000	35	2200	4	4 11/32	4⅛	84	17.67 19 65	17.67	22.62	93	93	1–24	8¾	6⅞	143	No. 4	5400	10,200
G.E.- 800	25	1800	4	5 1/16	4⅛	81	14.67	14.67	14.67	105	105	1–27	9⅛	7⅞	203	No. 6	4600	8,500
G.E.- 90	50	2489	5½	4⅜	4	86	15.71 17.69 19.67	15.71	22.64	29	145	1– 8	9⅝	..	90½	No. 2	6765	13,750
G.E.- 87	60	3430	5½	3½	4	87	16.71 18.69 20.67	16.71	23.64	43	129	1–11	11	9⅛	87½	2 No. 4's	8035	16,290
G.E.- 80	40	2830	5½	4⅛	4	86	15.71 17.69 19.67	15.71	22.64	37	111	1–10	9⅝	7¾	110½	5BWG	6540	12,750
G.E.- 74	65	3574	6	3½	4⅛	89	16.73 19.70 22.67	16.73	28.61	39	117	1–10	11¼	..	70½	1.531 ×.053	8318	15,736
G.E.- 73	75	4147	6	3½	3⅝	75	17.58 19.56 21.54	17.58	24.51	39	117	1–10	13¼	..	120	1.125× .080 1×.080	9634	19,382
G.E.- 70	40	2785	5½	4	4⅛	86	17.69 19.67	15.71	22.64	37	111	1–10	9⅝	..	110	5BWG	6430	12,530
G.E.- 67	40	2425	4½	4½	4⅝	84	17.67	15.69	24.60	37	111	1–10	9⅛	7½	110	.220	5800	11,000
G.E.- 66	125	4425	5¾	3½	3¾	89	19.70	16.73	35.54	39	195	1–10	14⅜	..	85	1⅛× .120 1×.120	11,600	22,000
G.E.- 57	50	3002	4½	3½	4⅛	85	19.66	18.67	26.59	33	99	1– 9	10¼	9¼	110	.035× 1⅛	7000	14,200
G.E.- 54	25	1861	4	5⅞	4⅝	81	14.67	14.67	14.67	29	115	1– 8	8½	6⅞	128½	No. 4	4650	8,500
G.E.- 52	25	1500	4	..	..	84	17.67	15.69	24.60	29	87	1– 8	8	6⅛	155½	No. 5	4650	8,500
West. 101 B	40	2730	5	4⅛	4	84	15.69 18.66 22.62	15.69	26.58	37	111	1–10	10¼	8¾	110½	.078× .625	6600	12,500
West. 93 A	60	3360	5½	3⅜	3⅝	87	16.71 19.68 24.63	16.71	35.52	45	135	1–11	10¼	8½	78½	.043 ×1.25	7310	14,700
West. 92 A	35	2265	5	4⅜	4 3/16	84	15.69 18.66 22.62	15.69	26.58	41	123	1–10	9	7¾	125½	.078 ×.5	5570	10,500
West 49	35	1920	4	4¾	4⅛	82	14.68 18.64	14.68	24.58	59	117	1–14	8⅜	6⅝	114	No. 4	4900	9,300
West. 12 A	25	2270	4	4¾	4⅜	82	14.68	14.68	14.68	47	93	1–12	8⅜	6⅞	187	No. 6	5400	10,100
West. 12 A	30	2200	4	4¾	4⅜	82	14.68	14.68	14.68	47	93	1–11	8⅜	6⅞	187	No. 6	5400	10,100
West. 12 A	30	2270	4	4¾	4⅜	82	14.68	14.68	14.68	47	93	1–12	8⅜	6⅞	187	No. 6	5550	10,400
West. 12 A	30	2270	4	4¾	4⅜	82	14.68	14.68	14.68	47	93	1–13	8⅜	6⅞	187	No. 6	5400	10,100
West. 12	25	2640	4	4	3⅞	82	14.68	14.68	14.68	47	93	1–25	8¾	6⅞	180	No. 8	5400	10,100
West. 3	25	2600	4	6½	5	80	18.62	18.62	18.62	95	95	1–25	8¾	6⅞	180	No. 8	5400	10,100
West. 112	65	3411	6	3¾	3 7/16	89	16.73 20.69 24.65	16.73	35.54	45	225	1–11	12½	11	60½	.062× 1.25	8000	15,750

Note.—G.E.-73 motor is 2½-inch pitch gear. All others 3-inch pitch.

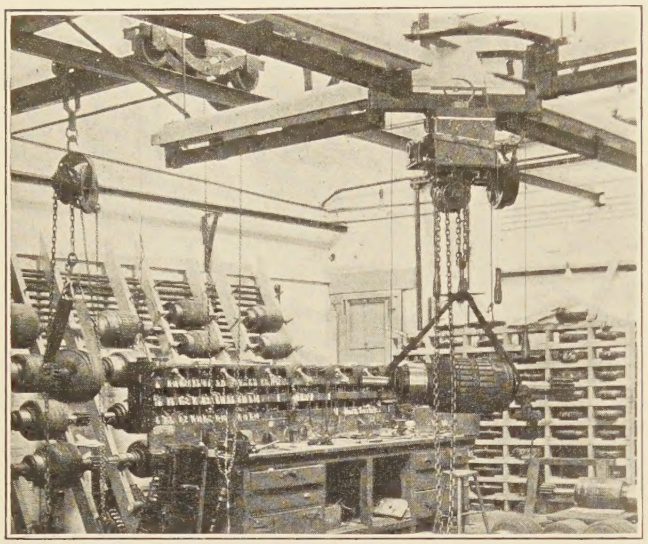
Hartford Shops—Data Sheet on Twenty-four Types of Railway Motors

ment with the new metal. The two pieces are then welded and turned down to the proper diameter.

COMMUTATOR SLOTTER

The company is now slotting the commutators of GE-80 and GE-54 motors to a depth of 1/16 in. It is planned to extend this practice to all the other types of motors as soon as the present supply of hard brushes is exhausted. A description of the commutator slotting machine which has been used since April 12, 1909, is presented in the following paragraphs.

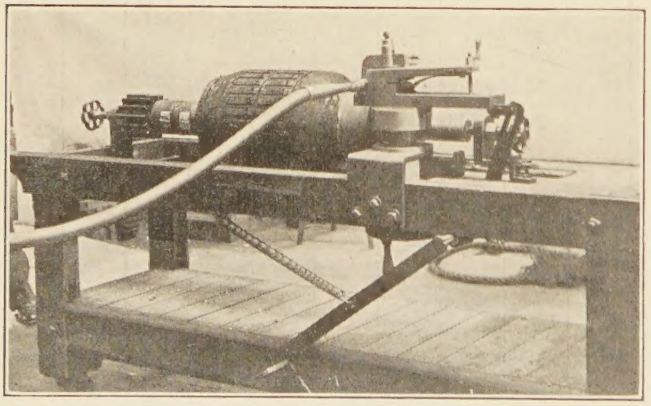
The commutator slotter as shown in the illustrations is



Hartford Shops—Motor-Operated Armature Hoist

the outcome of several attempts to design a machine that would be efficient, accurate and easy to operate. The method of mounting the armature in the lathe between centers and slotting with a special tool holder operated by a lever was tried for a while but was given up. This practice gave fairly satisfactory results, but the necessary time to slot a commutator was too long. It took two to four hours on a machine which could otherwise have been used for a more suitable class of work.

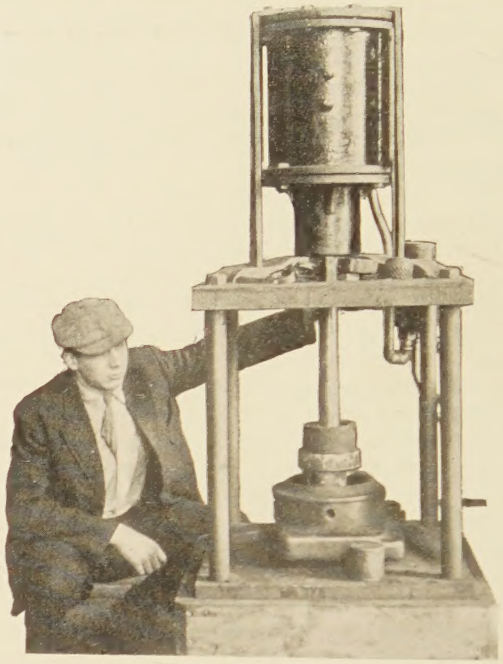
The present design requires less than one-half the time. Little skill is required to operate it, as the chief work of the attendant is to turn the commutator round to the proper position so that the tool may slot accurately between the bars. The tool holder consists of an old lathe slide rest from which the screw cross-piece has been removed. The



Hartford Shops—Slotter with Flexible Shaft Drive

slide is actuated by means of a pedal. The vertical movement which is necessary to accommodate varying commutator diameters is provided for by a column fitted to the slide rest and working in a sleeve which is securely bolted to the frame of the slotting machine. By means of a hand wheel and thread the tool holder can be raised and lowered, and it is perfectly rigid in any position because of the careful fitting of column and sleeve.

The cutting tool is a small slotting saw bolted to a shaft which runs in trolley wheel bushings. These bushings are fitted in a sleeve with a tool steel projection, so that the slotting saw, spindle and bearings can be instantly put in or removed from the tool part, as shown in the cuts. By means



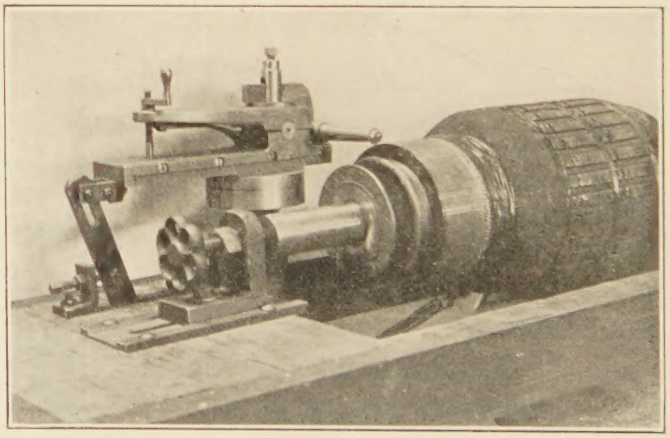
Hartford Shops—Air Press for Bearings

of two adjustable slots which the pedal touches at both ends of its stroke, the length and position of the cut can be regulated to a nicety. Power is obtained through a flexible shaft which is spliced to the spindle and is operated at the other end by means of a round leather belt from the overhead shop shafting. Two adjustable centers to provide for a maximum and minimum length of shaft and a solid table complete the equipment.

The whole device is mounted on castors and can be moved about. The armatures are very readily installed with a small shop hoist. This slotter was so inexpensive that it repaid its cost of manufacture in a very short time.

CUTTING HOLES FOR HEADLIGHTS

An effective method of cutting holes in dashers was de-



Hartford Shops—Commutator Slotter Ready for Service

vised when it was decided to furnish all Hartford city cars with incandescent headlights. The saw shown in the cut on page 537 was rigged up to do this work without chipping or taking the dashers off of the platforms. The device consists chiefly of the foot of an old trolley base, slotted near the edge to take the circular saw and drilled around

the rim for the insertion of set screws to hold the saw. The use of a continuous saw insures an ample number of bearing points on the work at all times. A hole is first drilled in the center of the dasher to serve as a guide. To prevent any slipping, the sawing tool is maintained permanently in the same position against the dasher by means of the clamping frame shown. With this tool a headlight hole can be made either by hand or air operation in ten minutes, or about one-third of the time which would be required by chipping.

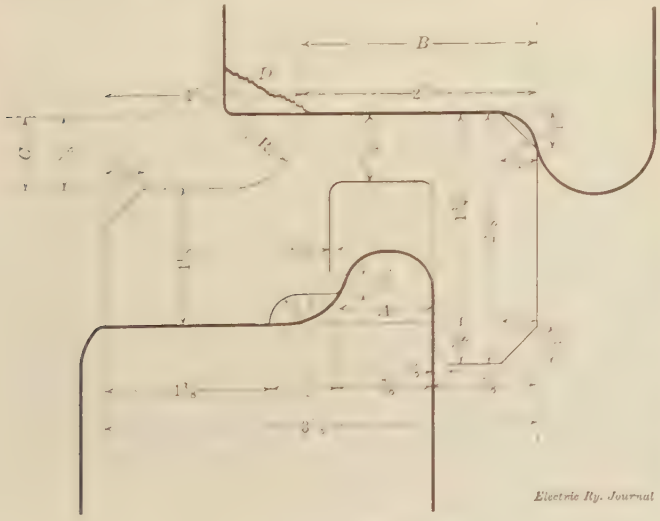
MISCELLANEOUS PRACTICES

A simple yet effective means is used to paint fenders. They are not coated with a brush but are just dipped into about 2 in. to 3 in. of Sterling fender compound, which floats on top of the water in wooden tank. The fenders are then set aside without any further attention and dry in from fifteen minutes to twenty minutes.

Circular Saw for Cutting Headlight Holes

The wheel limit gage developed in these shops is of hardened tool steel 1/16 in. thick, shaped as shown in the accompanying drawing. When a wheel is in such condition that the gage will set on the wheel, as per *A* on the drawing, the wheel is taken out and turned. If taken out at this time, the turning does not decrease the diameter of the wheel more than 3/8 in. The section of the gage marked *B* is used for gaging broken treads on cast-iron wheels. When the tread is chipped as far as the point *D* the wheel is condemned. The limit *C* is for chipped or worn flanges. When the flanges reach *C* they are not permitted to run under interurban cars, but they are still available for city service, subject, of course, to frequent inspection. The company also expects to make other uses of different parts of this gage than those which have been described in this article.

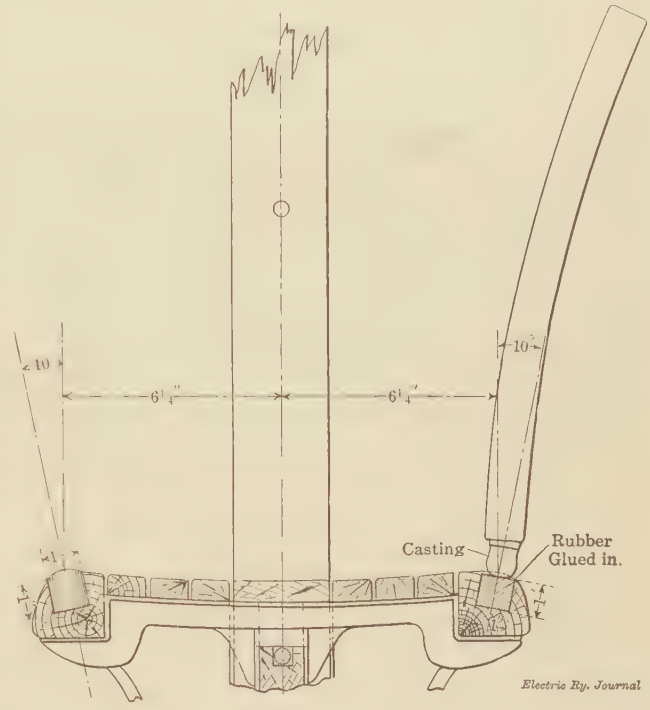
The proverb "Out of sight out of mind" has been made to apply in Hartford to the preservation of car equipment by concealing the rubber buffers in the seats of open cars instead of following the usual custom of attaching them to the edge of the seat back, where they are sure to tempt the passenger who owns a pocket knife. As shown in the accompanying cross-section, the buffers are depressed flush with the bench, the shock from the seat backs being transmitted by rounded castings.



Hartford Shops—Wheel Gage

CAR BUILDING AND RECONSTRUCTION

From time to time the Vernon Street shops have built and equipped utility cars for the transportation, track, and line departments. Among these cars is the combination rotary snow plow and line car illustrated in two of the accompanying views. This car is carried on Peckham 14-B-3 trucks, which are furnished with M. C. B. wheels to permit operation over the electrified (catenary) steam lines between Hartford and Melrose, Melrose and Rockville and Melrose and Vernon. The electrical equipment comprises motors of 35-hp capacity. The tower of this car is raised by a chain hoist to a maximum height of 17 ft. 6 in. above the rails. The ladder to the platform is raised and lowered jointly with the tower. The tower platform has folding rails as indicated in one of the illustrations mentioned.



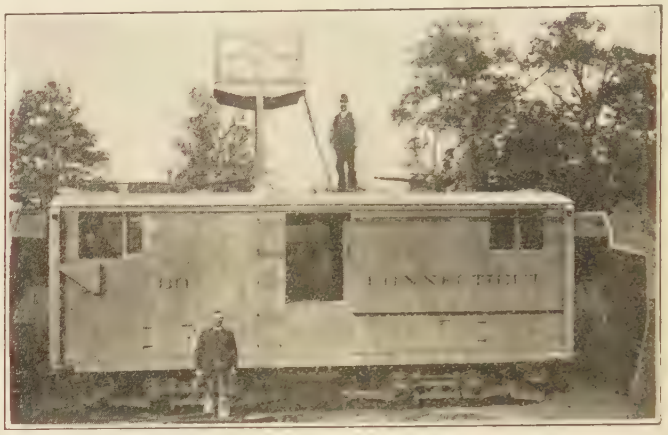
Hartford Shops—Depressed Rubber Buffers in Benches of Open Cars

Two wrecking cars were built for use in Hartford. The double-truck wrecker, shown on page 539, is 31 ft. 4 in. long. It is mounted on Taylor S. B. trucks which carry four Westinghouse 93-A motors. Part of this wrecking car was left open to make it available for carrying scrap, broken vestibules, etc. The single-truck wrecking car has fire-hose bridges in addition to the usual wrecking tools.

Hartford Shops—Cutting Headlight Holes

The supply car illustrated on this page is 36 ft. 6 in. long. It is mounted on two Standard O-50 trucks which carry four GE-80 motors. The air brakes are of the Westinghouse semi-automatic type. One end of the supply car is arranged with conveniences for the crew. The opposite compartment has a wrecking tool outfit. This car is used for handling supplies between Hartford, New Haven, Waterbury, Manchester, Rockville, Middletown, Meriden and New Britain.

Hartford Shops—Tower Car with Tower and Ladder Down



Hartford Shops—Tower Car with Tower and Ladder Up

One of the most unusual car construction jobs was the rebuilding of five Wason forty-eight-passenger cars, each 32 ft. long. These cars were damaged in a fire at the old Middletown carhouse, and one of them, in fact, had nothing left except the bottom frame, trucks and electrical equipment. At that time the car builder was too busy to consider the reconstruction of these cars, so as an experiment the railway decided to rebuild the one in worst condition. The work was begun in May, 1910, after a set of drawings from the Wason Manufacturing Company had been secured, and was finished within two months.

HINTS ON AIR BRAKE OPERATION AND MAINTENANCE

In conclusion, it may be of interest to quote from some instructions prepared by A. Blanchard, superintendent of these shops, on the operation and maintenance of straight air brakes.

"Don't work motor-driven compressors more than 50 per cent of each hour. If the proper size has been chosen, with the apparatus and piping in good condition, a compressor in braking service should not operate more than 30 per cent of the time even in city service.

"Don't allow the equipment to run with the governor out of order, trusting to the motorman to start and stop the compressor when necessary.

"Don't work the motor-driven compressor against a pressure of more than 100 lb.

"Don't run a 600-volt compressor on a line having more than 650 volts.

"Don't connect the armature lead to the trolley and field lead to ground; this is the reverse of what the connections should be.

"Don't run a compressor without a proper size fuse in its circuit.

"Don't block the vent pipe.

"Don't leave the motor door open.

"Don't forget to oil the compressor regularly.

"Don't forget to keep the commutator clean and the brushes free in their holders.

"Don't permit the suction screen to clog up with dirt.

"Don't allow the brake rigging to become so slack and the shoes so worn that the travel of the brake cylinder piston will exceed 8 in.; otherwise the air brake will not be effective.

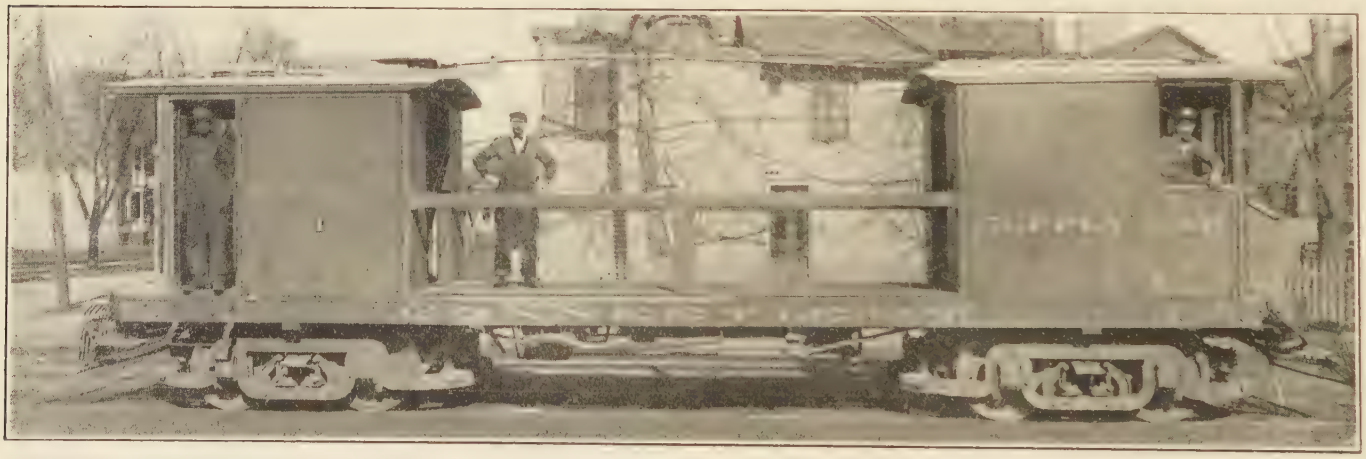
"Don't keep a car in service if there are any bad leaks in the piping; such a condition compels the compressor to be in constant operation.

"Don't allow the motorman to 'fan' the air-brake handle. This manner of operating wastes air, makes uneven stops and causes much unnecessary wear and tear to the apparatus.

"Don't fail to see that the bolts and nuts are tight; this can be determined when the motor is being inspected.

"Don't imagine the air brake can last indefinitely without lubrication; it does not differ in this respect from other machinery.

"Wherever feasible the brakebeams should be so hung that their distance above the rail will be uniform regardless of the weight of the car. This practice will largely reduce the danger of flat wheels, because loading and unloading in a car will not affect the piston travel, which may be ad-



Hartford Shops—Supply Car Made at the Vernon Street Shops

justed for the proper length of stroke, irrespective of whether the car is ready or not.

"It is better to fasten a brake cylinder to the car body by means of an iron plate instead of by a wooden block, because the latter will shrink, thereby causing the loosening of the plates and permitting movement of the brake cylinder every time the brakes are operated. When the brakes are applied the brake rods should be as nearly parallel as possible with the longitudinal line through the center of the car, and the brake levers should stand as nearly as possible at right angles to the rods. Wherever possible the brakeshoes should be hung inside of the wheels and the hangers be so

Hartford Shops—Wrecking Car

inclined that gravity will cause the shoes to swing clear of all wheels. Outside-hung brakes tend to cause the forward end of the truck frame to tilt down when the brakes are applied with a resulting slacking off of the shoes at that end. The other end of the truck tilts up with the tightening of the shoes and may cause the wheels to skid because the friction at the different connections prevents an equalization of pressure under the new conditions."

TREATMENT OF DEPRECIATION AND MAINTENANCE IN GREATER NEW YORK

A table showing the policy followed by the street and electric railway companies in Greater New York in reference to depreciation is published herewith. It was compiled for the Electric Railway Journal by A. F. Weber, statistician of the New York Public Service Commission for the First District, and shows the rates which were adopted during the fiscal year ended June 30, 1911.

The uniform system of accounts prescribed by the commission provides for a definite charge and also states that the unit of charge may be the car mile. It will be noted that most of the companies have adopted this unit, although some use a flat rate per month or per year, while one company sets aside a percentage of the cost. A number of the companies operating in Manhattan and the Bronx have made no particular provision under the system of accounts for the treatment of depreciation in this way. Most of these companies have been in the hands of receivers. The two principal companies, the Metropolitan Street Railway and the Third Avenue Railroad, now reorganized as the New York Railways Company and the Third Avenue Railway Company, respectively, have been ordered by the commission to set aside 20 per cent of their operating revenue for depreciation and maintenance.

It will be noticed that marked variation exists in the rates set aside by the companies for the charges for maintenance and depreciation combined. While the rates given are those that were used by the companies during the fiscal year ended June 30, 1911, they are not in all cases the rates that were established when the system of accounts was first adopted under the order of the commission. Changes have been made from time to time by some of the companies.

RATES OF DEPRECIATION ADOPTED BY STREET AND ELECTRIC RAILWAY COMPANIES IN ACCORDANCE WITH THE UNIFORM SYSTEM OF ACCOUNTS PRESCRIBED BY THE PUBLIC SERVICE COMMISSION FOR THE FIRST DISTRICT—FISCAL YEAR ENDED JUNE 30, 1911

Company	Unit Basis	Charge for Maintenance and Depreciation Combined—Way and Structures	Equipment	Total	Amount of Depreciation Reserve at Close of Year (a)
ROADS ENTIRELY ELEVATED OR UNDERGROUND					
Hudson & Manhattan	Per month	$4,842.50	$2,466.75	$7,309.25	(b)$417,009.39
I. R. T. { Subway division	Cents per car-mile	1.30	1.76	3.06	(c)
I. R. T. { Elevated division	Cents per car-mile	1.33	1.38	2.71	(c)
Brooklyn Union Elevated	Cents per car-mile	1.10	2.00	3.10	789.85
BROOKLYN RAPID TRANSIT SURFACE COMPANIES					
Brooklyn Heights	Cents per car-mile	2.40	3.00	5.40	243,484.94
Brooklyn, Queens County & Suburban	Cents per car-mile	2.20	2.70	4.90	14,586.92
Coney Island & Gravesend	Cents per car-mile	2.40	4.40	6.80	5,731.44
Nassau Electric	Cents per car-mile	2.20	2.70	4.90	40,796.47
Sea Beach	Cents per car-mile	1.80	1.40	3.20	(d)
South Brooklyn	Cents per car-mile	1.20	1.70	2.90	41,189.43
MANHATTAN SURFACE ROADS					
Metropolitan Street, Receivers	For replacement of horses	....	No rule	No rule	26,717.50
Central Park, North & East River	For replacement of horses	....	No rule	No rule	27,563.48
Second Avenue, Receiver		....	....	....	.....
Twenty-eighth & Twenty-ninth Streets, Crosstown, Receiver.	Per cent of operating revenues	10	5	15	63,692.37
Dry Dock, East Broadway & Battery, Receiver		...	....	....	(e)
Forty-second Street, Manhattanville & St. Nicholas Avenues, Receiver		....	....	....	.....
Third Avenue, Receiver		....	....	....	.....
BRONX SURFACE ROADS					
Southern Boulevard		....	....	....	.....
Union, Receiver		....	....	....	.....
Westchester Electric, Receiver		....	....	....	.....
Yonkers, Receiver		....	....	....	.....
City Island		....	....	....	.....
Pelham Park		....	....	....	.....
New York City Interborough	Cents per car-mile	0.80	1.40	2.20	5,980.98
QUEENS SURFACE ROADS					
Long Island Electric	Cents per car-mile	2.60	3.90	6.50	11,680.04
New York & Long Island Traction	Cents per car-mile	1.70	4.00	5.70	26,015.78
New York & Queens County	Cents per car-mile	2.50	2.00	4.50	17,351.56
Ocean Electric	Cents per car-mile	2.00	3.00	5.00	4,387.16
New York & North Shore Traction		....	....	....	.....
South Shore Traction	No rule	No rule	No rule	No rule	3,957.32
OTHER COMPANIES					
Bush Terminal	Per cent of cost	2	10	....	9,024.50
Coney Island & Brooklyn		....	....	....	.....
Marine	Per month	$27.00	28.75	$55.75	1,794.34
Van Brunt Street & Erie Basin	Annually	(g) $825.36	$1,944.48	$2,769.84	1,812.80
Richmond Light & Railroad	Annually	(g)$35,100.00	$31,800.00	$66,900.00	(f)19,884.77
Southfield Beach	Annually	$672.00	.....	$672.00	909.03
Staten Island Midland	Annually	(g)$27,300.00	$25,500.00	$52,800.00	12,265.52

(a) Accumulation since July 1, 1909.
(b) Depreciation only included in schedule; includes depreciation for terminal buildings.
(c) Expenditures exceeded amount charged to operating expenses for depreciation and maintenance as per rate filed with the commission; the difference is carried on books of company as a temporary debit.
(d) As per note (b) except that difference was charged to profit and loss.
(e) Company charged $1,951.94 to operating expenses and credited same amount to fixed capital, this representing depreciation in value of horses.
(f) Includes depreciation reserve of lighting department.
(g) Does not include charges to expenses for cleaning and sanding of track, removal of snow and ice, and minor miscellaneous charges.

Repair Shop Layouts

A Compilation of Figures from Ten Shops, Most of Them Recently Constructed—Consideration Is Given to Relative Areas of Different Departments, as Well as to Ground and Building Areas

In the twenty years' life of electric railways enough time has elapsed to place the general design of the repair shop beyond the experimental stage. Different railways have, of course, different conditions peculiar to their locations or methods of operation, yet the general problem of overhauling a certain number of cars of a certain average size is presented in approximately the same form in every case, and varies only in minor details. This general problem requires that each department which goes to make up a complete repair shop shall have a sufficient area for carrying on its work without crowding and yet not be so large as to involve an unnecessary investment for buildings or land. It is believed that past experience has, by a process of elimination and addition, determined approximately correct areas for the various shop departments,—and, in consequence, a series of averages taken from representative repair shops should determine a definite standard which may be expressed in exact terms. It is, of course, true that the individual ideas of different designers as well as local conditions have affected the arrangement and proportions of existing shops, but, in a set of averages from any large number of arrangements, these variations cancel out and become negligible in the general result. In order to obtain figures upon which to base averages, ten shops have been selected as representative. These are shown in the following table, which also gives the reference to the files of the Electric Railway Journal, where descriptions of the different shops may be found:

Shop	Railway	Reference
Milwaukee	Milwaukee Electric Railway & Light Co.	Feb. 4, 1911, p. 206
Baltimore	United Railways & Electric Co.	Apr. 4, 1903, p. 531
Seattle	Seattle Electric Co.	Oct. 2, 1909, p. 537
Rochester	New York State Railways	Apr. 11, 1903, p. 549
Anderson	Indiana Union Traction Co.	Apr. 4, 1908, p. 540
Minneapolis	Twin City Rapid Transit Co.	Oct. 10, 1908, p. 891
Portland	Portland Railroad Co.	Nov. 26, 1910, p. 1057
Syracuse	Oneida Railway Co.	Apr. 1, 1911, p. 551
Chicago	Chicago Railways Co.	Mar. 25, 1911, p. 492
Montreal	Montreal Street Railway Co.	Oct. 29, 1910, p. 908

PROPORTIONS

For the purposes of comparison each one of the ten shops has been divided into eight different departments, namely, (1) repair shop, (2) machine shop, (3) blacksmith shop, (4) carpenter or erecting shop, (5) storeroom, (6) armature room or electrical department, (7) wood mill, (8) paint shop and washrooms.

The repair shop is intended to include the building or area where general repair work is done upon cars. It includes the truck shop and the space provided for floor work on running gears, brake rigging and such repair work on controller wiring, sand boxes, railways, door rigging and the like as can be done either upon the car or without necessity for use of special appliances available in other departments. The machine shop and the blacksmith shop cover the space assigned to metal-working machinery, including the wheel shop. The carpenter or erecting shop provides space for heavy repairs upon car bodies and is distinct from the repair shop in that in the latter only light carpentry repairs which will not hold the car are done as needed. The storeroom is the building or room where stock material is kept and does not include storage space outside for heavy materials nor the interior space used for storing material immediately needed in the different departments such as bar iron for the blacksmiths and unmounted wheels at the wheel press. It does, however, generally include the shop offices. The armature room is intended to include space for strictly electrical repairs although the line of demarcation between this department and the machine shop is not well defined on account of the machine shop work done in stripping and testing motors, turning and slotting commutators and the like. The wood mill covers the space assigned to woodworking machinery and includes the cabinet shop wherever a separate room is installed for that work. The paint shop and washroom, in addition to the work indicated by the title, includes paint mixing and storage space, room for sash, doors and seat storage, and the varnishing rooms. Of the minor departments the dry kiln, and heating boilers, being subject to arbitrary considerations, are omitted in making up averages. The tin shop has been included with the blacksmith shop when possible, and the brass foundry, where one is installed, has been omitted as its existence depends upon whether it is the policy of the company to purchase or manufacture its brass fittings. Space devoted to inspection of cars or storage of cars has been omitted in every case for the same reason as these are operating and not strictly repair shop facilities.

Table I.—Relative Area of Departments Expressed as Percentage of Total Shop Area

	Repair Shop	Machine Shop	Blacksmith Shop	Carpenter Shop	Storeroom	Armature Room	Wood Mill	Paint Shop and Wash Room
Milwaukee	19.6	12.9	5.9	18.3	13.8	5.2	6.9	17.4
Baltimore	17.9	7.4	3.7	17.9	12.4	4.8	12.8	23.1
Seattle	17.4	10.8	3.1	13.9	18.1	6.5	7.0	23.2
Rochester	21.0	13.6	2.3	10.5	30.4	3.2	5.6	13.4
Anderson	22.0	8.3	3.3	17.5	16.4	5.6	9.7	17.2
Minneapolis	9.5	8.3	7.1	17.7	17.8	8.3	8.9	22.4
Portland	19.5	8.4	6.2	10.7	11.5	8.3	7.8	27.6
Syracuse	30.2	5.5	1.5	18.7	18.5	1.5	2.4	21.7
Chicago	21.1	12.6	1.4	22.5	4.8	4.1	15.2	18.3
Montreal	23.3	8.6	4.9	19.0	10.6	5.5	7.6	20.5
Averages	20.3	9.4	4.0	16.8	14.9	5.3	8.2	21.1

On this basis the area of each department of each of the ten shops has been determined and the relative area of each department has been expressed as a percentage of the total area of the shop. These percentages are shown in Table No. 1.

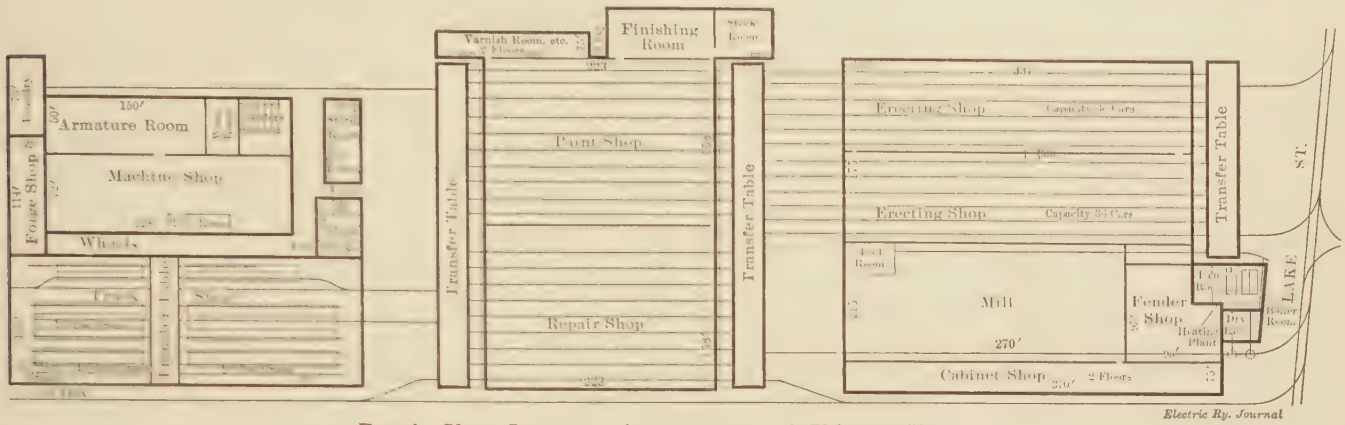
The list of shops shown has been made up without regard to size or the number, type or size of the cars served by it. It is possible that these factors may influence the relative areas of the different departments, but the table shows that any such influence is very slight. This may be accounted for by the fact that large cars will have large motors and heavy trucks and wheels. Large cars will also contain more wood than small ones, and all departments will increase in approximately the same proportion as more shop space is required to house the car bodies.

EXCEPTIONS FROM THE GENERAL AVERAGE

With few exceptions all of the shops seem to agree reasonably well with the average. Of the exceptions several can be readily accounted for, and for this reason may be considered to prove the rule. Notable among these are the Minneapolis and Syracuse shops with repair departments respectively 50 per cent and 150 per cent of the areas indicated as good practice by the average of Table I. The former is accounted for by the fact that part of a carhouse not shown on the drawing of the Minneapolis shops is used as a light repair shop. Since the area devoted to this purpose is unfortunately indeterminate, it has not been added in the repair shop area. The large size of the repair shop at Syracuse, on the other hand, has resulted in the space between the tracks being used for storage of various heavy materials. It is manifestly not a crowded department.

An exception in the case of machine shop area will be

found at Syracuse where no floor work is done in the machine shop. It is not necessary in this case, as there is ample room for that purpose in the unusually large repair shop adjacent to it. Two very small blacksmith shops are found in the cases of Syracuse and Chicago. At Syracuse contracts are made with outside local smithies for much of the blacksmith work and naturally only limited space is necessary. In Chicago the blacksmith shop is reported by the chief engineer of the Chicago Railways Company to be from normal in the size of the wood mill. At the former place no reason is assigned for this, although it is reported by the management to be very compact in arrangement. At Chicago the mill was purposely laid out so as to permit wagons to pass between the machines, and space for storing 50,000 ft. of lumber on the mill floor is provided. This naturally follows from the fact that no lumber storage could be provided outside, on account of location in a congested city. The paint shops in every case except Roch-



Repair Shop Layouts—Arrangement of Chicago Shops

badly crowded just as is indicated by the figures in Table I, and it is to be extended in the near future. The large blacksmith shop at Minneapolis can be accounted for by the fact that a large amount of manufacturing is done in the shop.

All carpenter shops seem to run reasonably close to the average, except possibly Portland, which is a small shop and not subject to any strict lines of demarcation between departments, and Rochester, which has small cars and narrow track spacing in the carpenter shop.

The exceptions to the rule in the case of storehouse areas are at Chicago and Rochester. The first may be accounted for by the fact that the shops are located in a large city where purchase of material of all kinds can be made on short notice, as well as the fact that the company has other store-

ester run reasonably close to the average, the maximum being 25 per cent above and the minimum 21 per cent below normal. The limited area of paint shop at Rochester may be accounted for on the same ground as the small carpenter shop at this point, namely, small cars and close track spacing.

From the foregoing it appears that a distinct relation between the areas of the various departments in repair shops has become established and that present practice in this matter is reasonably well standardized.

SIZE OF BUILDINGS

The actual areas of the building or buildings required for housing the various departments of the repair shop of any electric railway are, of course, subject to a number of obscure factors. Probably the readiest way to arrive at a

Repair Shop Layouts—Arrangement of Baltimore Shops

houses at different points on its lines. The large storage area at Rochester is clearly due to the fact that no material is stored outside the building, it being placed in a basement extending under the entire shop. Syracuse is again in evidence with an exceptionally small armature room, which is stated to be ample in size for the reason that no electrical equipment on the cars is overloaded or subjected to other abuse. It is reported that no motors are ever rewound at these shops. Syracuse and Chicago show extreme variations

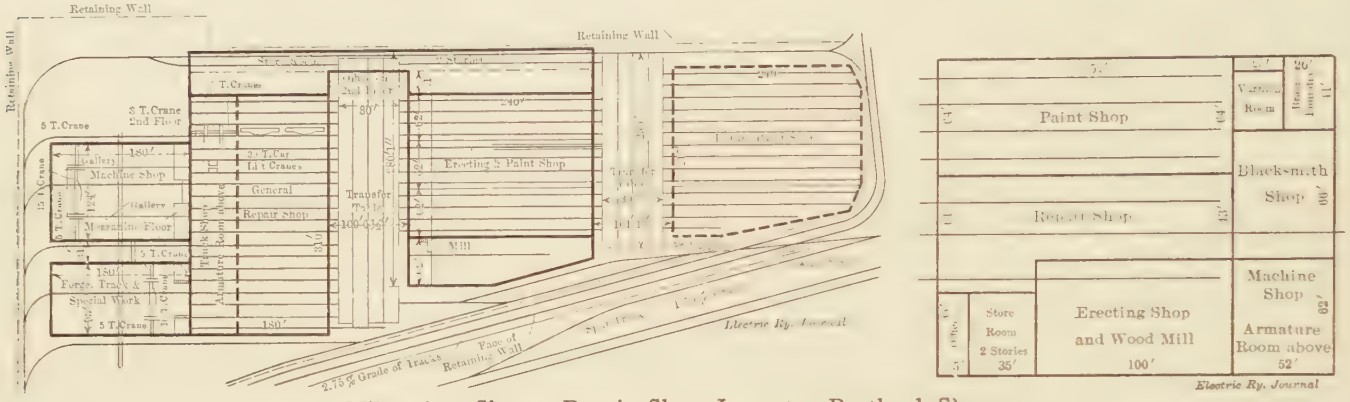
basis for comparison is to consider the areas in square feet per car served by the shop. It is granted that this is an exceedingly rough and ready method, but, in view of the fact that there is necessarily a certain relationship between size of shop and number of cars, Table II has been prepared to show the range through which this unit varies. In determining the areas given, only buildings have been included. No yard space of any kind is considered, and covered transfer tables where they exist have been omitted.

With the exception of Baltimore and Chicago, all shops seem to have an area approximating 200 sq. ft. per car owned. At Baltimore the tracks are spaced on 10-ft. 6-in. centers and this is unquestionably too narrow for efficient operation. If the track spacing were increased to the customary 16 ft., the area occupied by cars would be increased 50 per cent. As will be shown later, the space occupied by cars is approximately half of the total shop area so that the wider track centers would increase the total area 25 per cent and bring the area per car up to 172 sq. ft. At Chicago considerable work is done in the outside carhouses. This includes all light repairs, installing wheels, armatures and motors and overhauling trucks, so that the main shop is relieved to a considerable extent.

ing in many shops. This gives a total area of 900 sq. ft. required for each car which stands in the shop. However, the whole of the shop area is not devoted to housing car bodies, and by referring to Table I the average condition will be found to be as follows:

Space Not Used for Cars

	Per Cent.
Machine shop	9.4
Blacksmith shop	4.0
Storeroom	14.0
Armature room	5.3
Wood mill	8.2
Cabinet shop, varnish rooms, etc., say, 15 per cent of paint shop	3.3
Truck shop, say, 25 per cent of repair shop	5.0
Total	50.1



Milwaukee Shops—Repair Shop Layouts—Portland Shops

Table No. II.—Relation of Shop Areas to Total Number of Cars Owned by the Railway

Shop	Number of Cars Owned	Floor Area of Shop	Square Feet of Shop per Car
Milwaukee (*a*)	1,500	284,600	190
Baltimore	1,780	243,400	137*
Seattle	450	82,900	184
Rochester (*b*) (*c*)	236	56,000	237
Anderson	300	70,200	244
Minneapolis	787	168,800	215
Portland	210	38,400	183
Syracuse (*c*)	250	65,900	264
Chicago	2,200	262,100	120†
Montreal	570	111,500	196
Average of results	...	.....	197
Totals	8,283	1,383,800	167

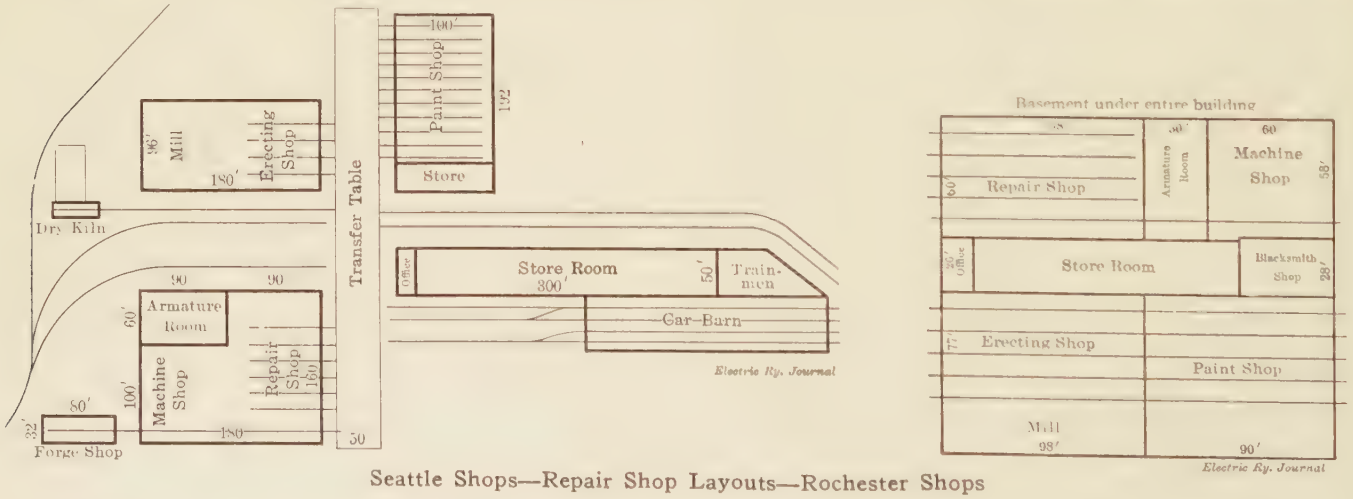
(*a*) Number of cars estimated. (*b*) Number of cars based on annual output of shop. (*c*) Floor area includes part basement.
* Two bays used for car storage not included.
† All light repairs are made at carhouses.

Influence of Various Factors

The same result may be arrived at in a somewhat different manner by assuming that each car in the shop occupies a space 60 ft. long and 15 ft. wide. The length of 60 ft. is based on a 45-ft. car body with a 7-ft. 6-in. space at each end for passageway, trucks and waste room. The width is assumed arbitrarily from the track spacing existing in many shops. This gives a total area of 900 sq. ft. required for each car which stands in the shop. However, the whole of the shop area is not devoted to housing car bodies, and by referring to Table I the average condition will be found to be as follows:

In other words, approximately half of the shop is used for housing cars and the other half for machinery and floor work. If each car requires 900 sq. ft. of space in which to stand, the total area of shop for each car contained in it will be twice that, or approximately 1800 sq. ft. Then, if 10 per cent of the equipment is held in the shop at any one time for repairs, accidents or rebuilding, 10 per cent of 1800 sq. ft. of shop area will have to be provided for each car owned. This amounts to 180 sq. ft. of shop per car, which checks fairly well with the figures indicated in Table II.

This is undoubtedly the most accurate method for arriving at the proper size of shop for any electric railway, as it permits allowance for the requirements of variations in length of car body as well as for unusual conditions which might necessitate frequent shoppings due to numerous accidents or excessive wear. The latter allowance may be made by using judgment in selecting the expected percentage of cars held in the shop. In crowded city streets, for instance, where accidents are common, it would not be unreasonable to assume that 12 per cent of the cars owned might be held in the shop. On the other hand, where equipment is first class and conditions good, it is safe, as shown in Table III on the next page, to reduce the figure to



Seattle Shops—Repair Shop Layouts—Rochester Shops

8 per cent. The method can, in fact, be expressed by the formula:

$$\text{Shop area in square feet} = 2 \times L \times S \times C \times P$$

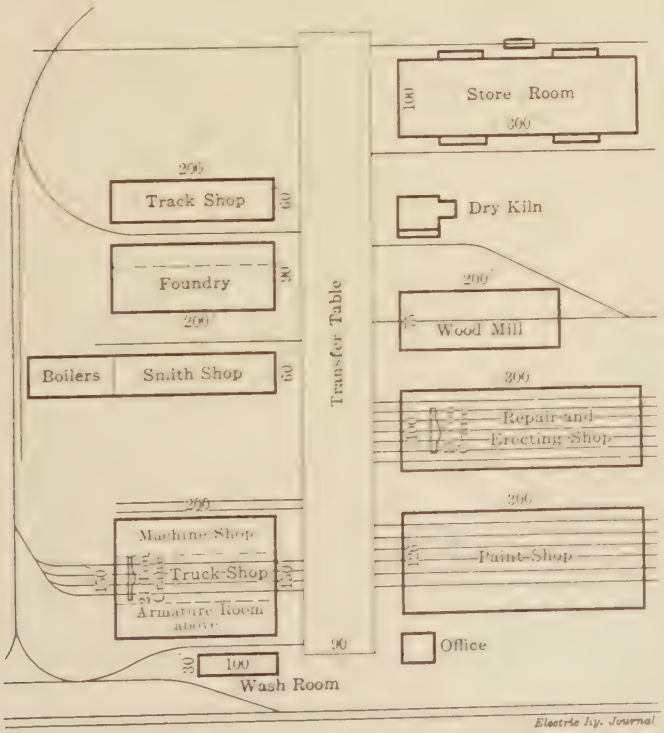
where L = length of average car plus 15 ft.
S = track spacing (generally 15 ft.).
C = number of cars owned by the railway.
P = maximum percentage of cars held out of service in the shop (generally 10 per cent).

As a further check on these figures Table III has been prepared to show the approximate capacity in cars of each of the ten shops here considered, also the percentage of the total number of cars held in the shop and the number of square feet of shop for each car which it can hold. The figures in column 6 are obtained by dividing those in column 4 by those in column 5. The figures in column 8 are obtained by dividing the figures in column 7 by those in column 4.

Table III.—Relation of Shop Areas and Number of Cars Owned to the Number of Cars Which Can be Got Into the Shop

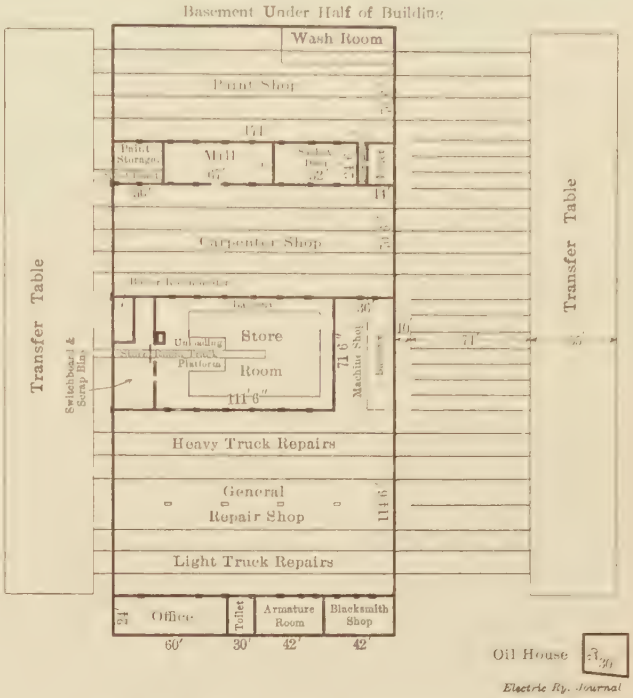
	Capacity in Cars (50 ft. long) (1) Repair Shop	(2) Erecting Shop	(3) Paint Shop	(4) Total Number of Cars Held by Shop	(5) Total Number of Cars Owned by Road	(6) Per Cent of All Cars Held by Shop	(7) Area of Shop in Square Feet	(8) Square Feet of Shop per Car Contained in
Milwaukee ...	40	48	52	140	1,500	9.3	284,600	2,030
Baltimore	56	64	64	184	1,780	10.8	243,400	1,320
Seattle	7	8	22	37	450	8.2	82,900	2,240
Rochester	5	10	10	25	236	10.6	56,000	2,370
Anderson	12	12	12	36	300	12.0	70,200	1,950
Minneapolis	35	36	71	787	8.9	168,800	2,370	
Portland	4	3	12	19	210	9.0	38,400	1,940
Syracuse	18	12	14	44	250	17.6	65,900	1,500
Chicago	36	72	50	158	2,200	7.2	262,100	1,650
Montreal	15	21	18	54	570	9.5	111,500	2,070
Averages ...	19	28	29	76	...	10.3	.....	1,944

The figures in column 8, or the area of shop per car housed, correspond to the value $2 \times L \times S$ given in the formula and are comparable to the figure of 1800 mentioned in the example previous to that. The figures in column 6, or the percentage of cars owned which can be housed in the shop, correspond to the term P in the formula.



Repair Shop Layouts—Minneapolis Shops

The fact that the Syracuse shops can hold over 17 per cent of the cars on the road is not necessarily evidence that they ever do so. The peculiarly large repair shop at Syracuse accounts for this condition; for, while this department has capacity for eighteen cars, there is no indication that it ever needs to hold over eight. The low area of shop at Baltimore per car contained, as shown in column 8, may be accounted for by the fact that the shop tracks are set on 10-ft. 6-in. centers. The latest practice calls for 15-ft. and 16-ft. centers, and this would add about 25 per cent to the figures shown.



Repair Shop Layouts—Syracuse Shops

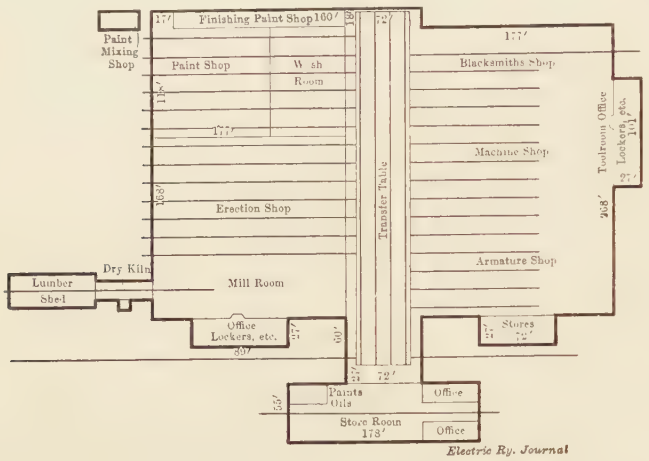
GROUND AREAS

In the foregoing only the areas of buildings or floor areas of the various departments have been considered. It is, of course, undesirable to build a shop upon a plot of ground of the exact size of the building. There are many classes of material, such as wheels, iron castings, lumber, scrap and the like, which can be conveniently stored outside of the shop building, and this is undoubtedly better than to have them occupying valuable space under roof, or to have them kept in a storeyard at some distance from the shop. In addition to this it is not unusual to make use of the shops for storing and repairing track material so that a need exists for a plot of ground considerably larger than the shop buildings. Unfortunately no set relation appears to exist between building and ground areas. However, Table IV has been prepared to give a conception of present practice in regard to the total area of ground required. The figures have been worked out in three ways, each column showing the same area expressed in different form.

Table IV.—Areas of Shop Grounds

	Area of Ground and Buildings in Acres	Per Cent of Building Area	Area per 100 Cars Owned, in Acres	Area per Car Owned, in Square Feet	Remarks
Milwaukee ...	9.5	144	0.63	273	
Baltimore	11.9	214	0.67	292	Separate buildings.
Seattle	9.0	470	2.00	870	Basement area not included.
Rochester	0.9	115	0.31	133	No transfer table.
Anderson	5.5	342	1.83	800	Separate buildings. Includes track material.
Minneapolis ..	19.7	510	2.50	1090	
Syracuse	3.6	236	1.44	620	
Chicago	11.0	180	0.49	214	Basement area not included.

It will be noticed from Table IV that a marked difference in area of ground required exists between those shops which are composed of separate buildings and those in which all departments are grouped under one roof or are located in two or three large buildings separated only by narrow transfer tables. The former arrangement offers a



Repair Shop Layouts—Montreal Shops

much greater protection against disastrous fires, permits better natural lighting facilities, and, especially for large shops, gives an opportunity for greater flexibility in design. However, it appears from Table IV that the spaces between the different buildings are not needed, aside from their value for fire protection, and that separating departments in different buildings necessitates a considerably greater

Table V.—Areas of Miscellaneous Departments

	Dry Kiln	Lumber Store	Boiler Room	Percentage of Total Building Area Occupied by Boilers	Brass Foundry	Pattern Store	Toilet and Locker Rooms	Percentage of Total Building Area Occupied by Toilet Facilities
Milwaukee	....	....	....	..	....	....	2,620	..
Baltimore	....	....	4,500	2	....	....	5,000	2
Seattle	....	....	....	..	600	....	....	..
Rochester	....	....	1,250	2	....	....	....	..
Anderson	....	2,500	....	..	1,250	....	1,200	2
Minneapolis	4,900	....	6,000	4	....	....	3,000	2
Portland	....	....	....	..	1,100	....	....	..
Syracuse	....	....	1,500	2	....	....	700	1
Chicago	1,000	....	1,500	0.5	2,400	7,500	2,200	1
Montreal	1,000	3,000	....	..	....	....	2,000	2

ground area for the shops. The low figure of 0.31 acre per 100 cars owned which is shown for Rochester is due to the fact that this shop has a basement extending under the entire shop building. This in effect makes a two-story shop and, as has been mentioned before, gives the shop an unusually large storeroom. The area outside of the shop usually allowed for heavy storage has in this case been put into a basement. The same arrangement obtains in a limited degree at Syracuse, where part of the shop building is provided with a storage basement. Chicago, as shown in Table II, has a layout characterized by decidedly restricted building area in consideration of the total number of cars owned, so that it is evident that the minimum ground area required for a complete set of shops is somewhere between 0.49 acre per 100 cars owned, as at Chicago, and 1.83 acres, as at Anderson. The latter shop, as shown in the cut, is located on a triangular plot of ground which is at best difficult to utilize. In round numbers, it is probable that 1 acre per 100 cars owned is sufficient, or at least desirable, for a compactly designed shop. When separate buildings are used for the different departments, and especially where considerable quantities of track material are stored, 2 acres per 100 cars owned appears to be the least possible ground area which should be provided.

Miscellaneous Departments

The dry kiln lumber store, boiler room and brass foundry, as already stated, are departments whose areas are not necessarily dependent upon the considerations affecting the proportions of the rest of the shop. Where the information can be obtained the areas of these minor departments has been shown in Table V.

Provision for Growth

Examinations of the shop arrangements shown in Figs. 1 to 10 disclose the somewhat unexpected condition that only a minority of the ten contain distinct provision for

Table VI.—Factors Indirectly Affecting Shop Areas

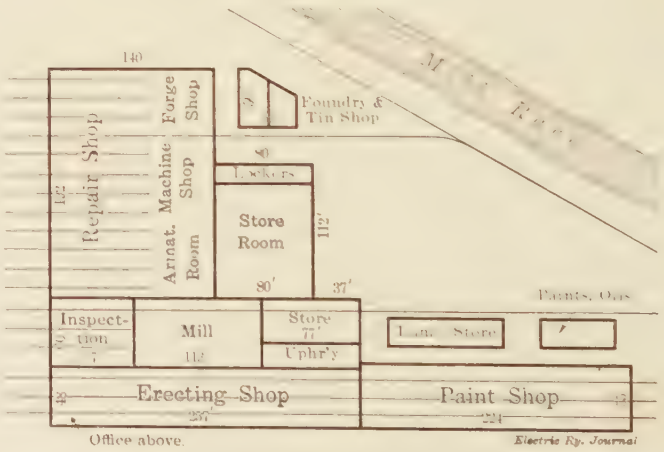
	Track Spacing: Repair	Track Spacing: Erecting	Track Spacing: Paint	Per Cent of Tracks with Pits	Method of Lifting Cars Off Trucks	Transfer Table Provided	Armature Room on Second Floor	Use of Tracks Which Hold More than Two Cars: Repair	Use of Tracks Which Hold More than Two Cars: Erecting	Use of Tracks Which Hold More than Two Cars: Paint
Milwaukee	15½	15½	15½	29	Traveling electric cranes	yes	yes	..	yes	yes
Baltimore	10½	10½	10½	66	Chain hoist	yes	..	yes	yes	yes
Seattle	16	16	14	..		yes	..	..	..	..
Rochester	11	11	11	48	Screw hoist Jacks	..	..	..	..	..
Anderson	16	16	16	33	Traveling electric hoists	..	..	..	yes	yes
Minneapolis	15	14	15	..	Traveling electric cranes	yes	yes	yes	yes	yes
Portland	16	16	16	63	Jacks	..	yes	yes	yes	yes
Syracuse	14	14	14	45	Hydraulic lift	yes	..	yes	yes	yes
Chicago	15½	14	15½	25	Traveling electric cranes	yes	..	yes	yes	yes
Montreal	16	16	16	39		yes	..	..	yes	yes
Totals						7	3	5	8	8

future extension. It is, of course, possible to extend any shop provided that sufficient ground area is provided around it, but in most of the layouts shown an extension could only be made by shifting departments or adding to the sides instead of to the length of the buildings.

Miscellaneous Considerations

Although matters which are not included in a discussion of shop areas are not within the scope of this article, a number of features of the different shops under consideration affect indirectly the areas of the different departments, and for that reason they are shown in Table VI.

The matter of track spacing, or the distances between



Repair Shop Layouts—Anderson Shops

centers of tracks, is the most important matter covered in the table. The average for all of the ten shops is approximately 14 ft. 6 in. for all departments. However, of the ten shops, Baltimore and Rochester were built prior to 1903, or more than five years before the other eight. The present tendency seems to be strongly in favor of a wider spacing.

If these two shops are omitted the average spacing becomes as follows:

Repair shop	15 ft. 7 in. c. to c.
Erecting shop	15 ft. 5 in. c. to c.
Paint shop	15 ft. 1 in. c. to c.

Of the methods used for raising cars off trucks, electric traveling cranes or hoists appear generally to be preferred. However, their use does not actually tend toward compactness of shop. Crane installations are not confined to the largest plants, although it would seem that they are peculiarly adapted to such shops.

Transfer tables are used by seven out of ten shops in preference to ladder tracks. This preponderance of opinion is evidently due not only to the convenience and speed of the transfer table but also to the high cost of the complicated overhead work and switches necessary without it. The location of armature rooms on a gallery or second story does not appear to be generally favored even in some of the shops located in congested city districts.

Tracks which hold more than two cars are favored strongly for the erecting and paint shops, while opinion is about evenly divided for repair shops. The objection sometimes advanced to this arrangement, to the effect that it necessitates holding cars which may be finished before their turn, and also involves more complicated switching, therefore, does not appear to be considered seriously.

EXPERIENCES WITH STEEL TROLLEY WIRE

Steel trolley wire is a comparatively recent product of the wire manufacturers, and only a few electric railways have had any of it in use for a sufficient length of time to determine its relative life and behavior in service as compared with copper wire. As now manufactured, steel wire is hard-drawn from billets in a way like that employed for copper wire except that the lengths before splicing are shorter owing to the wear on the drawing dies, which must be changed frequently. The metal used is, in fact, not steel, but is a very high-grade iron low in carbon and phosphorus and hence not subject to active corrosion. The tensile strength of a No. 0000 round steel wire is about 65,000 lb. per square inch, as compared to 59,000 lb. for hard-drawn copper wire. No difficulty has been experienced with steel wire in making splices or welds not exceeding ½ in. in length and having a tensile strength of 80 per cent of the wire on either side of the splice. The steel wire is easily coiled on reels, which are of slightly larger diameter than those used for copper wire, and it comes off the reel straight and true if it is not kinked in unwinding. The relative conductivity of steel and copper wire is approximately one to seven.

In order to ascertain the experiences of several railway companies which have put up sections of steel trolley wire, the Electric Railway Journal requested information from the Philadelphia Rapid Transit Company, Trenton & Mercer County Traction Company, Brooklyn Rapid Transit Company, Virginia Railway & Power Company, Richmond, Va., the New York, New Haven & Hartford Railroad and other companies. The replies of several of these companies are abstracted below.

PHILADELPHIA RAPID TRANSIT COMPANY

The Philadelphia Rapid Transit Company strung 13,490 ft. of No. 0000 grooved steel wire over both tracks on Market Street between Broad Street and Delaware Avenue in February, 1909. The traffic on this line is the heaviest in the city. The steel wire was taken down in June, 1911, after two years and four months of service and was replaced by No. 0000 round phono-electric wire. The No. 00 round copper wire formerly used over these tracks had a life of two years and six months. On Walnut and Chestnut Streets, which carry almost as heavy traffic as the Market Street line, approximately 13,000 ft. of phono-electric wire was put up in December, 1906, and will be renewed this spring after giving a little more than five years' service. When removed the steel wire was found to have worn at the ears, which in some cases exceeded 75 per cent of the cross-section of the wire. There was very little evidence of pitting or corrosion and comparatively little wear in the sections between supports. In fact, most of the wire retained its original cross-section between the supports. This led the company to believe that the difficulty with the wire was due not to the character of the material but to the nature of the support, as the same kind of wear was found with both copper trolley wire and phono-electric wire when suspended with clips. The company is now installing only round wire suspended with clinched ears.

The steel trolley wire in Philadelphia was erected in three feeder sections. The length of one section from Delaware Avenue to east of Third Street was 1136 ft. This section had taps to a 1,500,000-circ. mil underground feeder every block. The cars were operated over this section during the peak load about 300 ft. apart at a speed of 590 ft. per minute, or about 6¾ m.p.h., and the load taken from the section varied from 100 amp to 1300 amp. The second section extended from east of Third Street to east of Ninth Street. Its length was approximately 2662 ft. with taps every block to a 1,500,000-circ. mil underground feeder. The cars operated on this section at intervals of about 300 ft. and the total load was from 100 amp to 1700 amp. The third section was from east of Ninth Street to Broad Street. It was 2900 ft. long with taps every block to a 1,500,000-circ. mil feeder. The cars on this section operated at about the same speed and interval as on the other two sections and the total load was from 180 amp to 1200 amp. In erecting this steel wire no change was made in the number of taps which were formerly used with the No. 00 copper wire.

TRENTON & MERCER COUNTY TRACTION COMPANY

The Trenton & Mercer County Traction Company in October, 1908, equipped two tracks of a double-track line 750 ft. in length with No. 0000 steel trolley wire on South Broad Street, Trenton, where a ten-minute car service is maintained during the day. Originally the wire had practically no feeder connection except at the ends, but since that time the company has installed feeder connections at about every five spans. Under these conditions the cars seem to have no difficulty in securing power. Measurements for wear were taken at the end of the first six months and after that at the end of each year. Most of the corrosion or wear seems to have been caused during the first six months. The average wear on the wire, measured in loss of diameter, during the three years in which it has been in use has been 0.0775 in. The measurements were taken at each clamp, and in no place does it appear excessive. The copper wire used throughout the rest of the system is No. 00 B. & S., and it is believed that at least half of the wear which has been found on the steel wire is due to the pinching of the wire in the trolley wheels, as the trolley wheels were designed for a No. 00 section of wire and not for a No. 0000 wire, the size of the steel trolley wire.

VIRGINIA RAILWAY & POWER COMPANY

The experience of the Virginia Railway & Power Company in the use of steel trolley wire has been so satisfactory that it expects to install 20 miles on lines of heavy traffic within the next six months. At the present time the company has in use 7 miles of No. 0000 grooved steel wire. One mile of this wire on Olney Road and Botetourt Street in Norfolk was erected two years ago, and the remaining 6 miles have been up one year. Approximately 233,000 car movements have been made under the wire on Olney Road and Botetourt Street since it was erected. The average current taken from the wire by each car is 100 amp, but a recent examination of the wire shows no evidences of pitting or corrosion. More arcing is caused under the steel wire than under copper wire, but no excessive wear on the

trolley wheels has been noticed. The measurement of wear made at the time of the examination showed a loss of about 6 per cent in the cross-section, or at the rate of 3 per cent per year. The current taken from the wire during the first year after it was installed was excessive, as the track below was nearly worn out and was not removed until the beginning of the second year. Under similar conditions the company states that a No. 00 copper trolley wire would now need renewing. Feeder connections are made to the steel trolley wire at every fifth span as against every tenth span for copper wire.

NEW YORK, NEW HAVEN & HARTFORD RAILROAD

The New York, New Haven & Hartford Railroad has been the largest user of steel trolley wire. It now has in service between Woodlawn and Stamford 110 miles of this wire and within six months will have installed an additional 222 miles on its Harlem River branch and on the New York, Westchester & Boston Railroad. On the New Haven road the No. 0000 grooved steel wire is supported below a No. 0000 copper conductor wire at intervals of 10 ft. by small clips and the catenary hangers are attached to the copper conductor wire midway between these clips. With this construction the steel wire takes the wear of the sliding collector shoes or pans and the copper conductor provides the necessary conductivity. W. S. Murray, electrical engineer of the railroad, states that the steel wire was put up in 1908 and as yet shows absolutely no signs of pitting or corrosion. The life as estimated from frequent measurements of wear at points of maximum traffic is estimated at more than twenty years. No difficulty has been experienced by this company in the erection of steel trolley wire and the maintenance cost has been greatly reduced as compared with that of the original construction in which the copper conductor wire also took the wear of the pantograph shoes.

CONNECTICUT COMPANY

The Connecticut Company has 5750 ft. of steel trolley wire on its Hartford-Middletown line and 100 ft. of steel trolley wire in special overhead work in New Haven. The wire is No. 0000 B. & S. gage and American Standard grooved. The wire on the Hartford-Middletown line has been in use about two and one-half years and there have been approximately 33,000 car movements under it. The average number of amperes taken from it per movement has been 175. The wire is in a catenary with a copper messenger, and the hanger spacing varies from 10 ft. to 50 ft. All the hangers undoubtedly act as feeders from the copper messenger to the trolley. The section on the Hartford-Middletown line has been examined frequently and shows no serious pitting or corrosion, but has a coat of fine red dust. There is apparently a little more arcing on the steel trolley wire than on the copper trolley wire, and at night there is apt to be a brush effect behind the wheel, due apparently to the rust on the wire. The New Haven section of steel trolley wire is only 100 ft. in length and is at the corner of State Street and Chapel Street, a busy intersection. It has been in place for about three and one-half years. The company has not sufficient data yet to enable it to form an estimate of the comparative life of steel and copper trolley wire under the same conditions, but based on the Middletown installation, the wear is apparently somewhat greater on steel wire than on copper wire.

PACIFIC ELECTRIC RAILWAY

The Pacific Electric Railway, of Los Angeles, installed a section of No. 0000 double-grooved iron trolley wire in February, 1910, over one of the tracks of its Pasadena short line between Oneonta Junction and Sierra Vista Junction. This track is used for freight service as well as for passenger service. As there are two long curves in the track over which the wire is installed, the company expected to find considerable wear at these points, but very little has been discovered, either at the clips or splices. This wire is installed over a track which is a slight down grade, and the cars operate over it in one direction only. The company has not noticed any injurious sparking between the wire and the trolley wheel, but is not positive what the effect of sparking would be on heavy grade service where greater density of current would be transmitted between the wire and the trolley wheel. On inspection it was noticed that the top section of the wire has a very heavy coat of rust. This indicates, in the opinion of the company, that it would be advisable either to tin or to galvanize the wire. On the whole the company believes that better results can be obtained from iron wire than from copper wire, especially at points where there is great wear.

CHICAGO, LAKE SHORE & SOUTH BEND RAILWAY

The Chicago, Lake Shore & South Bend Railway, a single-phase line, is using steel trolley wire between the Indiana-Illinois State Line and Pullman, Ill., a distance of approximately 9 miles. The wire was erected about six months ago, is a grooved section, size No. 0000, and has been in service approximately four months. The car movements where this line is in use will approximate sixty during each twenty-four hours. The wire is carrying single-phase alternating current at 6600 volts, so that the amperage collected from the wire by means of a sliding pantagraph shoe is comparatively small. So far there is no appreciable wear, no pitting or corrosion. The wire is very much harder than the material which is used in the pantograph shoes.

The company reports that, while it has no means of definitely determining the relative wear of steel trolley wire and copper trolley wire under the conditions existing on its line, there is every reason to believe that the steel wire will last much longer than copper wire. The copper wire used on the company's westbound track shows considerable wear after three years' service, and the steel trolley wire will be substituted for this wire within a short time. There is practically no arcing from either the steel or the copper trolley wire. The steel wire on the eastbound track is suspended under the copper trolley, which is used as a feed wire, the steel wire being about 2 in. below the copper wire, and both the copper and steel trolleys are supported from a catenary steel cable. This form of construction, so far as the position of working conductor is concerned, is similar to that on the main line of the New York, New Haven & Hartford Railroad.

COOLING PONDS FOR CONDENSING WATER

W. B. Ruggles recently presented before the American Society of Mechanical Engineers the results of tests made upon a reservoir or cooling pond used for the purpose of dissipating the heat in the circulating water discharged from a condensing power plant. The cooling pond upon which the tests were made was installed in order to avoid the cost of the power which would have been required to pump circulating water to the condensers from the nearest water supply. The cooling pond was installed in preference to some form of cooling tower which ordinarily would be used for such conditions.

The pond was found to dissipate approximately 3½ b.t.u. per square foot per hour per 1 deg. Fahr. difference in temperature between water and air This figure remained roughly constant under all conditions and at all seasons and it included the heat absorbed both by conduction and by surface evaporation. The heat absorbed per square foot of pond surface per hour amounted to 133 b.t.u. in May, 118 b.t.u. in July and 140 b.t.u. in the latter part of November.

The tests led the author to the conclusion that under ordinary conditions, in the northern part of the United States, a cooling pond or reservoir having a surface of 120 sq. ft. per hp would be ample for cooling the condenser discharge from engines using 15 lb. of steam per hp-hr., and that it would maintain in ordinary weather a vacuum of 26 in.

The Illinois Traction System's New Brass Foundry and General Shop Notes

Description of New Foundry Equipment, Methods of Manufacture and Costs of Bearings and Hardware—Article Also Describes New Shop Kinks and a New Design in Swing Links

The Illinois Traction System has centered at its Decatur shops the brass foundry work of its large interurban system and its fifteen street railway properties. The volume of the work is such that the installation of permanent foundry facilities of considerable magnitude was warranted as an addition to the main shops at Decatur, which are under the charge of E. R. Johnston, superintendent of shops of the Illinois Traction System. Although excellent results have been obtained in brass foundries where one man could be steadily employed, much lower production costs may be expected when the output is large enough to keep occupied a force sufficient in size to carry out the complete processes of making the molds, pouring and chipping the castings.

A force of three men is employed in the Illinois Traction System brass foundry. They consist of an expert molder, who is paid 37½ cents an hour, and a core maker and an apprentice, who are paid 20 cents an hour each. These men produce all the brass and bronze castings required by the road and on an average turn out 800 lb. of castings in a ten-hour day. The castings include all the car hardware used in repairs and on new equipment built at these shops except the parcel racks and grab-handles, all bearings, motor-axle linings, controller contact bars, trolley wheels and lock sets.

FOUNDRY BUILDING AND BRASS FURNACE EQUIPMENT

The brass foundry occupies a comparatively small space, 22 ft. x 42 ft., in one end of the blacksmith shop and stock-room building which was recently built 50 ft. distant from the machine shop section of the main shop building. The foundry is generously lighted by large windows and sky-lights, and the ventilation problem, which is vital in successful brass foundry operation, particularly during cold weather, owing to the quantity of furnace gases which must be disposed of, has been solved by the installation of a large monitor running the full length of the roof, provided with fixed louvers on all four sides.

The brass furnace consists of three No. 70 Dixon crucibles placed in a pit 3½ ft. deep which is grated over except above the crucibles where openings with cast-iron covers allow the crucibles to be removed. A general view of the furnace arrangement is shown. The draft for the furnace is supplied by an ordinary brick stack about 35 ft. high with an 8-in. x 16-in. flue opening. When it is necessary to rush the work a small direct-connected motor-driven fan is used to furnish forced draft. A differential hoist attached to a long swinging arm has been installed over the furnaces to facilitate the handling of crucibles from the furnace when filled with another metal.

Two kinds of molding flasks are employed. One is the usual form of all-metal flask, and the other is a metal-bound wood flask used for the large castings. All molding, where possible, is done with metal multiple pattern plates. An electrically heated sheet-metal core-drying oven has been installed, as shown in one of the illustrations.

COST OF MANUFACTURE

The fact that standard designs have been adopted for practically everything which the brass foundry is now making materially reduces the cost of manufacture. As an evidence of the low costs obtained, standard 6-in. trolley wheels are now made for 59 cents each. This cost also includes all machine work and an overhead and depreciation charge of 20 per cent. Armature bearings for the pinion end of GE-73 motors are made for $3.19 and the commutator end bearings for $2.26. Axle-bearing linings for the same motors are made at a cost of $8.88. This company has found the manufacture of car brasses to be unprofitable due to the fact that bearing manufacturers are able to secure the lower grade brass at less cost because they buy in such large quantities.

RESULTS FROM USE OF ALL-BRASS BEARINGS

No babbitt is used in any of the bearings made at these shops, and excellent mileage results are credited to the care in manufacture and the mixture that is used. This mixture

Decatur Shops—Brass Furnace

is similar to that used on the Pennsylvania Railroad for the better class of bearings. It consists of 30 per cent lead, 68 per cent copper and 2 per cent tin. In case the mixture includes scrap brass of known composition the quantity of tin is increased 3 or 4 per cent, and the lead is reduced in proportion. This bearing metal has a light bronze color. It is comparatively soft but very tough. These qualities reduce the labor cost of turning and boring the bearings. The lathe used for turning and boring operates at 300 r.p.m., and GE-73 armature bearings are bored and turned for 15 cents each.

The work of finishing the bearings has been greatly facilitated by the use of an expander mandrel. This mandrel is made from a hollowed piece of shafting slightly coned and of sufficient length to extend through the longest bearing. The large diameter of the mandrels, which are made special for the different sized bearings, is about 1/100 in. larger than the finished inside diameter of a bear-

ing. The tapered portion of the mandrel has been slotted with ⅛-in. longitudinal slots at intervals of 1 in. throughout the entire circumference. The bearing when ready for turning is slipped on the tapered end of the mandrel, then forced to a secure position and then the whole is inserted in the lathe.

Mr. Johnson says that since using this bearing formula

Decatur Shops—Brass Foundry Showing Sand Bins, Pattern Plates and Molding Flasks

Decatur Shops—Pouring Off Metal into Molding Flasks in Brass Foundry

he has not had a broken bearing. An example of the service obtained from this bearing metal is found in armature bearings of some large motors on an old sleeping car which makes a 200-mile run from Springfield to St. Louis and return with very few stops. These bearings operate at

Decatur Shops—Core-Drying Oven in Brass Foundry—Wheel Lathe Chuck, Showing Dogs

high unit pressure and formerly it was necessary to replace them at intervals of two days. As manufactured of the new metal, these bearings now require changing only on thirty-day intervals.

The simple employment of this bearing metal formula was not all that was necessary to obtain the good service.

would cost approximately 45 cents per pound. The difference in the total cost of material is evident, even though the cost of replacing the babbitt after it has worn through is not considered. The cost of remelting all-brass bearings is no greater than the cost of replacing the babbitt lining when the labor and materials are both considered.

PATTERN SHOP

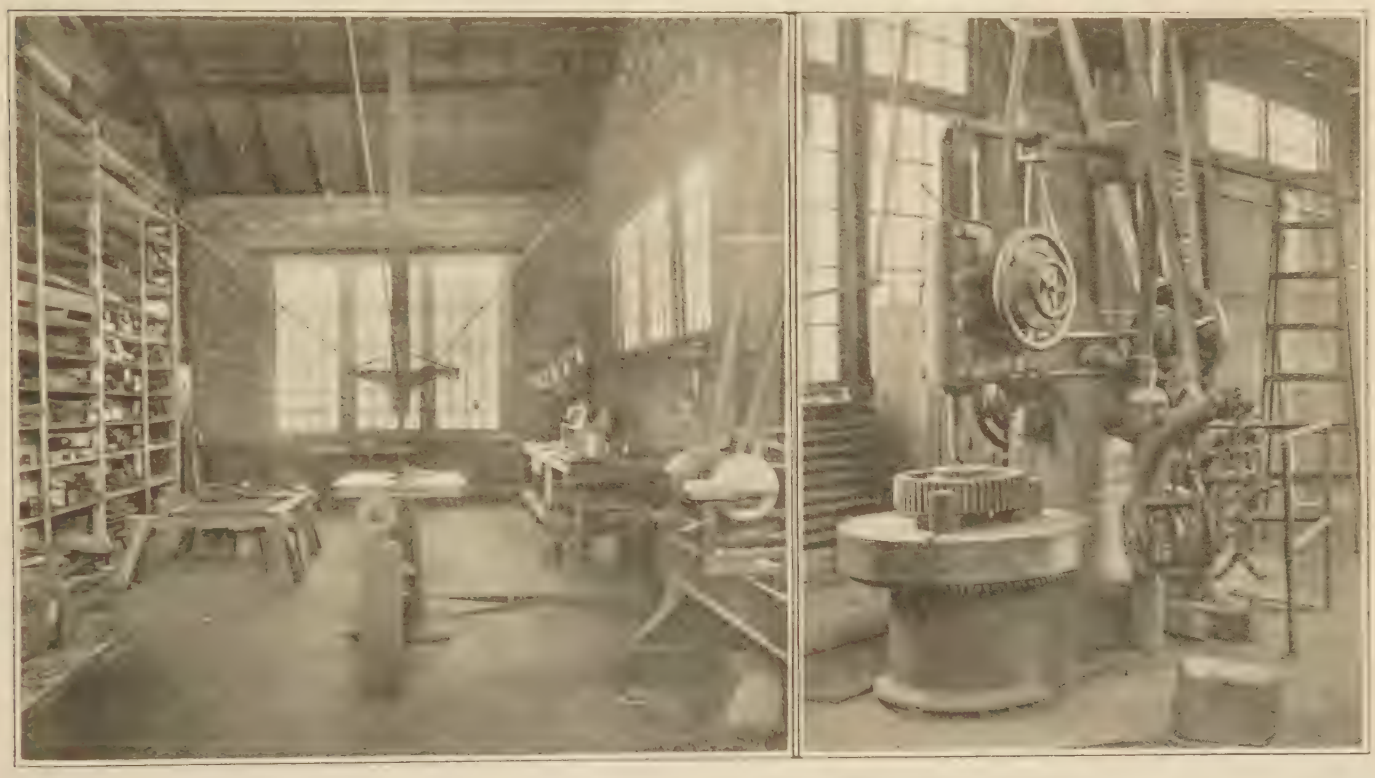
All wood and metal patterns used in the brass foundry are made in the company's pattern shop, which occupies a floor space about 20 ft. by 48 ft. on the second floor of the wood-shop building. One man is employed steadily making patterns not only for brass foundry use but for the car builders to whom the traction company furnishes patterns of all its standard casting designs. A view of the pattern shop is shown.

SHOP METHODS FOR HANDLING SCRAP AND NEW MATERIAL

The means taken for securing the return of scrap brass and other valuable materials are of interest, in connection with the foundry and shop practices followed at Decatur. About one-half of the metal poured in the brass foundry is remelted scrap.

When a car is brought into the Decatur shops for a general overhauling it is first given the usual inspection and a job number. The necessary materials for the repair of this car are issued only on an order signed by the foreman. These orders show the job number and the car number. The storekeeper fills out this form with the list of materials requested by the foreman. Triplicate copies are made if the material is ordered from the shop stock; one is held for the storeroom record, one is sent to the general shop foreman's office and one is delivered to the foreman with the material. The foreman receipts his copy and returns it to the stockroom for record. If the material needed for the repair of the car is not on hand at the shop storeroom, four copies are made. One is retained by the shop stock department and the other three are sent to the general storehouse which is located near the Decatur shops. When the order is filled the general storehouse prices the material on all three copies, keeps one and returns two with the remaining forms and the material. One of these two latter copies is receipted for by the foreman originating the order and is then retained by the shop stock department. The other requisition is made for new supplies of brass, copper or other expensive metal, the supplies which they are to replace must be turned in or accounted for. This plan of requiring the receipt of an old bearing for a new one or of an old trolley wheel for a new one has resulted in more careful attention being given to the saving of scrap. The men now realize that a piece of brass is not to be thrown away, but that it should be delivered to their foreman so that it can be turned in for recasting, and as the foremen are responsible for the delivery of the scrap to the stock department at Decatur, they are particularly careful to obtain credit for the return of all valuable metal. This plan of holding the sub-department heads accountable for the return of scrap applies to the scrap iron and steel, as well as to the more valuable materials, and has resulted in bringing about considerable reduction in the cost of new metal.

At the storehouse in Decatur particular care is taken in the sorting and grading of the scrap metals, so that the stock department can make prompt deliveries of any quality of metal required by the foundry, and the highest prices



Decatur Shops—General View of Pattern Shop—Wheel-Boring Machine

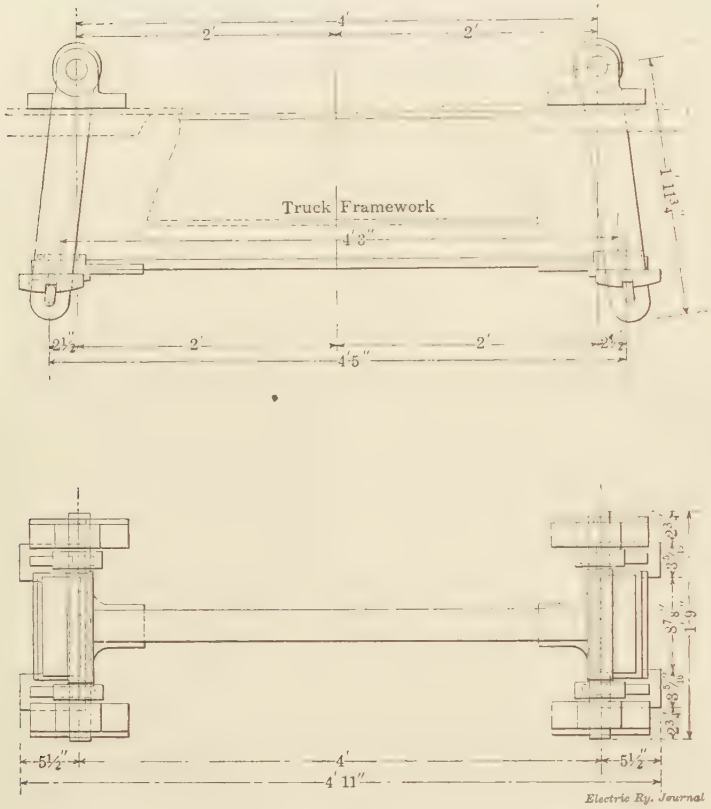
are received for sorted second-hand materials. In handling scrap the weight of new iron in standard shapes is estimated, but brass, copper, lumber, etc., are carefully weighed or measured.

WHEEL PRACTICE

Standard M. C. B. wheels are used under all rolling-stock equipment on the Illinois Traction System. The wheels are mounted according to gage which has been narrowed to within ⅛ in. of the M. C. B. minimum width. By means of this narrower mounting it is thought that a longer life is obtained because of reduced flange wear. The wheels used are 33 in. in diameter and show a life of 140,000 miles before the first turning. An M. C. B. gage is used for measuring the wear and determining when re-turning is necessary.

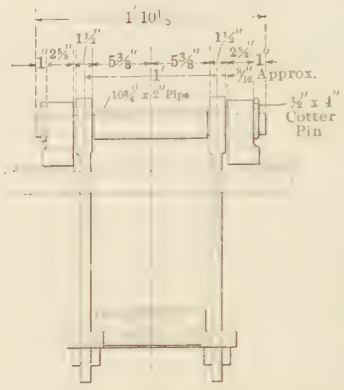
In the fitting of wheels to axles both new and old the process of measuring and boring has been greatly facilitated by using the Davis micrometer boring bar. As a large part of the machine work at the Decatur shops is handled on a piece-work basis, wheels for boring and fitting to new or old axles are allowed to accumulate until a sufficient number are on hand to keep the boring machines on one kind of work for a reasonable length of time. By this plan the volume of work is such that the entire process of fitting, boring and pressing a wheel on an axle can be performed continuously at the rate of two wheels per hour. The boring process for each wheel requires about fifteen minutes.

When a wheel is to be fitted to an axle, the axle is first calipered and the measurement transferred to the cutting edges of the Davis boring bar. The usual method in boring a wheel is to make a heavy roughing cut and leave sufficient metal for a finishing cut. The adjustment of the cutting tools in the boring bar can easily be made with the micrometer device, so that a close final measurement will be obtained. The micrometer adjustment on the Davis boring bar provides for accurate setting of the cutting tools to variations of 1/1000th in.



Decatur Shops—Detail of Swing Link and Spring Seat

The process of adjusting a pair of wheels in the wheel lathe has been considerably simplified by the use of special clamping dogs, devised and made by the shop forces. These dogs, as attached to one face plate of the large wheel turning lathe, are shown in an illustration on page 548. By their use the time required for clamping wheels in place is considerably reduced. Five clamping dogs are attached to each face plate, and each dog consists of an eccentrically mounted cam having teeth cut in its edges. By means of springs the cams are held away from the work, but when they come in contact with the rim of the wheel and the wheel is partly revolved the rough edges of the cam engage in the metal of the wheel, and any further tendency of the wheel to revolve on the lathe centers only tightens the grip of the cam-shaped dogs, thus holding the wheel secure for the application of the cutting tools. After the wheels have been finished they are released fro mthe dogs by a slight movement in the reverse direction.



NEW DESIGN OF SWING LINK

The frequency of road troubles caused by broken swing links has been greatly reduced since the shop forces designed the links with a new bottom fastening and placed these links on all trucks as they were brought into the shops for general repairs. An accompanying illustration shows the design of the new swing link. The chief feature of interest in this link is its method of fastening, which permits of ease of replacement. When it was necessary to repair the old type of swing link, considerable time was usually consumed in loosening the nut on the connection beneath the spring plank, and very frequently these nuts had to be split. In the new form of link the two are connected by a piece

Decatur Shops—View Showing Swing Link Applied to Truck

of iron so shaped that it fits into slots cut in the lower ends of the link and is held in place by means of a gib and cotters. Square shoulders on either side of the spring link provide for handling the heavy stresses. Since the new form of link was put into effect none has broken and the time of making repairs when necessary in general overhauling has been considerably reduced. The connecting bar between the two links of the new type may be removed by first jacking up the spring plank until the weight is released from the link, then removing the gib.

To remove excess stresses from the running gear when the cars enter curves at high speed, a change has been made in the angularity of the swing links. They are now set a little farther away from vertical and thus the cars adjust themselves a little more readily to sharp curves. This change in the pitch of the swing link and the new type of

links are being applied as fast as cars are brought into the Decatur shops for repairs. The cost of new links which are made in the company's shops is $4 per set.

ARMATURE AND FIELD COILS

The Illinois Traction System has been manufacturing a part of its own armature and field coils. Complete equipment for the manufacture of coils will soon be installed at the Decatur shops, this equipment to be designed for the manufacture of coils both for interurban and for all of the fifteen city railways operated by the McKinley syndicate properties. At the present time, with the simple equipment in hand, the coils for the use of GE-73 motors are manufactured for $12.18, and it is expected that this cost will be reduced considerably when the winding department is organized and has its new equipment.

RAIL CORRUGATION INVESTIGATION OF THE CHICAGO SURFACE RAILWAYS

A thorough inspection of 105 miles of the surface lines in Chicago, the purpose of which was to locate all corrugations and measure their depth and length, was recently completed. Owing to the fact that this is the first practical investigation of this kind and that the territory covered included those lines in which the traffic was densest and the speed the highest, the data presented herewith in tabulated form, as well as the methods employed in securing it, should be of interest and should develop some new theories on the subject of rail corrugation.

As has been noted in the Electric Railway Journal, the surface railways in Chicago are owned and operated by two separate companies—the Chicago City Railway Company, with 271 miles of track in the southern part of the city, and the Chicago Railways Company, with 445 miles of track in the western and northern sections of the city.

The purpose of the investigation was not to determine the reason for the appearance of the corrugations, but merely to locate them in order to facilitate the work of rail grinding. The total length of track affected by corrugations as well as the depth of the wave had increased to such an extent that it was believed the added vibration due to corrugations was materially increasing the cost of maintaining the cars.

Each company put a corps of three men at work after they had been thoroughly instructed as to just what in-

Chicago Railway Company's Corrugation Data

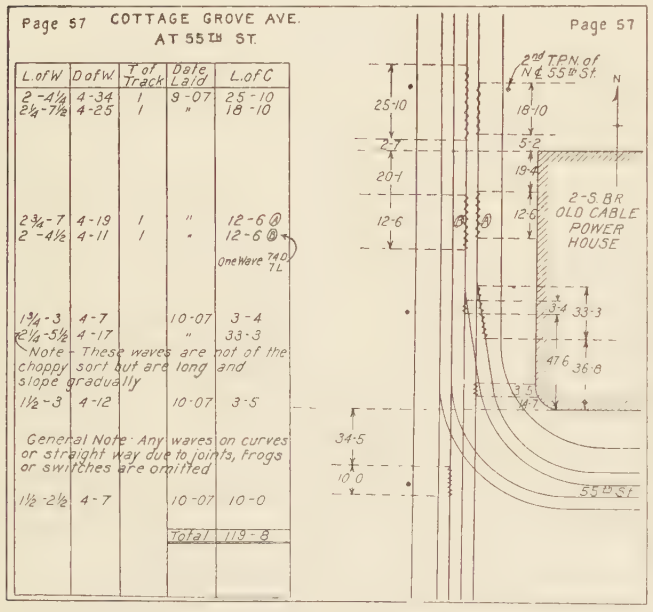
Street or Avenue	From	To	Age, Yrs.	Kind of Foundation	Depth of Foundation	Kind of Ties	Kind of Traffic	Depth of Waves Ave.	Depth of Waves Max.	Linear Feet of Double Track	Linear Feet of Rail Corrugation	Remarks as to Location
Clark	Howard	Washington	2½	Stone and Conc.	8-inch 6-inch	Wood	Moderate speed, very dense	In. .015	In. .031	94,700	2,089	.....
Madison	40th Avenue	State	3	Conc.	6-inch	Wood	Moderate speed, dense	.015	.031	52,800	2,218	.....
Halsted	River	Grace	2	Conc.	6-inch	Wood	Slow speed, dense	.015	.015	65,000	193	New subway portals.
Ogden	Randolph	Albany	1	Conc.	6-inch	Wood	High speed, dense	.015	.031	6,400	124	Curve approaches.
Milwaukee	Lake	Irving Park	3	Conc.	6-inch	Wood	Moderate speed, moderate	.015	.031	73,000	175	Curve and subway approaches
Chicago	Clark	60th Avenue	2	Conc.	6-inch	Wood	Moderate speed dense	.015	.015	74,800	7	Subway approach
Desplaines	Harrison	Austin	2	Conc.	6-inch	Wood	Moderate speed, dense	.021	.031	8,600	36	Viaduct approach
Lincoln	Center	Lawrence	3½	Stone and Conc.	8-inch 6-inch	Wood	High speed, light	.015	.015	45,100	6	.....
State	Madison	Division	2	Conc.	6-inch	Wood	Very slow speed, dense	.015	.015	11,000	37	Curve approaches
Twenty-first	Rockwell	Halsted	4	Stone	8-inch	Wood	High speed, moderate	.015	.015	21,000	30	Curve approaches
Western	Elston	Grand	1	Conc.	6-inch	Wood	Moderate speed, dense	.015	.015	32,100	22	Subway approaches; reverse curves
Van Buren	State	Kedgie	3	Stone	8-inch	Wood	Very slow speed, moderate	.015	.015	38,300	111	On high-speed track

Chicago City Railway Company's Corrugation Data

Street or Avenue	From	To	Age, Years	Kind of Foundation	Depth of Foundation	Kind of Ties	Kind of Traffic	Depth of Wave	Wave Length	Per Cent of Corrugation
South Chicago	75th	71st	4	Concrete	6-inch	Wood, steel	Moderate speed, moderate	.0067 in.	3.19 in.	21.10
Cottage Grove	71st	63d	4	Concrete	3 ft.	Steel	Moderate speed, moderate		3.17 in.	32.65
Cottage Grove	63d	55th	4	Concrete	3 ft.	Steel	High speed, moderate	.01 in.	3.50 in.	41.40
Cottage Grove	55th	39th	4	Concrete	3 ft.	Steel	High speed, dense	.011 in.	3.66 in.	65.25
Cottage Grove	39th	22d	3	Concrete	3 ft.	Wood	High speed, dense	.009 in.	3.45 in.	22.90
Indiana	22d	18th	2	Concrete	6 in.	Wood	Moderate speed, dense	.0085	3.75	46.10
18th	Indiana	Wabash	3	Concrete	6 in.	Wood	Slow speed, dense	.007	3.50	14.00
Wabash	18th	Randolph	3	Concrete	3 ft.	Wood	Moderate speed, dense	.008	3.69	26.85
Indiana	51st	39th	4	Concrete	6 in.	Wood	Moderate speed, dense	.006	3.55	20.40

formation was wanted. The work consisted of locating all corrugations, measuring their depth and wave length and keeping a precise record of all the information obtained. On the Chicago City Railways these men not only located the corrugations which were in need of immediate attention from the rail-grinding crew, but all corrugations which were continuous for 10 ft. or more were located when the depth was not less than 0.004 in. The reason for making the investigation on this company's tracks so precise was to procure information which could be used in determining the rate of increase in the depth of the wave in future observations. As is shown in the illustration of a page taken from the detailed notes, the location of all corrugations was permanently tied in to landmarks such as street intersections and lot lines.

The tools used consisted of a thickness gage of the leaf type, with leaves ranging from 0.004 in. to 0.25 in. in thickness, a steel straight edge 8¼ in. long and a 100-ft. steel tape. At first it was necessary to experiment with straight edges of several different lengths, but after a series of tests it was found that 8¼ in. would not span more than one wave length. As the light visible between the bottom line of the straight edge and the rail was used in determining the trough and crest of the wave, it was necessary to


Page 57 COTTAGE GROVE AVE. AT 55TH ST. Page 57

L. of W	D. of W	T. of Track	Date Laid	L. of C
2-4¼	4-34	1	9-07	25-10
2¼-7½	4-25	1	"	18-10
2¾-7	4-19	1	"	12-6 @
2-4½	4-11	1	"	12-6 @ One Wave 74 0 7L
1¾-3	4-7		10-07	3-4
2¼-5½	4-17		"	33-3
Note - These waves are not of the choppy sort but are long and slope gradually				
1½-3	4-12		10-07	3-5
General Note: Any waves on curves or straight way due to joints, frogs or switches are omitted				
1½-2½	4-7		10-07	10-0
			Total	119-8

2nd TPN of N ¢ 55th St. N
25-10 18-10 5-2 2-7 19-4 20-1 12-6 12-6 2-S. BR OLD CABLE POWER HOUSE 3-4 33-3 47-6 36-8 3-5 4-7 34-5 10-0 55th St.

Portion of Original Report on Corrugation

make the working line of the straight edge as thin as practicable. All measurements were taken at two-fifths of the width of the ball of the rail in from the gage line. In locating corrugations a record was kept of cupping due to faulty joints or flangeways in special work, but it was not used in arriving at the figures shown in the tabulations.

It required approximately thirteen weeks to cover the 20 miles of double track investigated for the Chicago City Railway Company. The type of rail used on all lines is the 129-lb., 9-in. grooved girder, Chicago section, and the kind of foundation and ties used is shown in the tabulation presented on page 551.

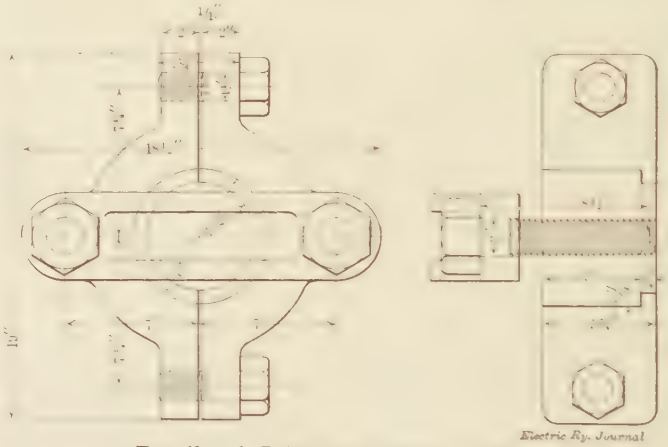
Owing to the anticipated extent of the investigation on the Chicago Railways Company's line it was decided only to measure and record corrugations whose wave depth exceeded 1/64 in. This accounts for the small percentage of corrugations when compared with the total length of track shown in the table. The amount of line covered included 86 miles of double track. A large proportion of this track is laid with wooden ties on a 6-in. concrete foundation, and approximately 20 miles is laid with wooden ties on 8-in. of crushed rock. The type of construction, as well as the fact that the lines carrying the densest traffic were not put in service until two years after those lines showing the maximum amount of corrugation on the Chicago City Railway lines, may account for a considerable proportion of the difference in the percentage of corrugations.

At the present time both companies are engaged in removing corrugations. Kerwin rail grinders were purchased and all work is being done between midnight and 5 o'clock in the morning. The linear feet of corrugations removed by the machines in the four-hour period each night ranges from 50 ft. to 500 ft. It requires two men to operate the rail grinder, which makes the average cost 0.9 cent per foot, not including the current consumption, oil and repairs. It is estimated that the total cost would approximate 8 cents per linear foot when all charges are included.

INGENIOUS PINION PULLER

The mechanical department of the Columbus Railway & Light Company has designed and manufactured a pinion puller the detailed construction of which is shown herewith. Several different sizes of pullers have been manufactured to fit the different-sized pinions used in the various equipments. The device is comparatively light and the cost of manufacture low, owing to its simple construction.

The pinion puller consists of a cast-steel ring made in two sections which are held together by two stud bolts. The inside diameter of the ring is the same as the over-all diameter of the pinion. One diameter was reduced, however, by cutting 1/32 in. from the adjoining faces of each section so as to permit the ring to be clamped tightly in



Details of Columbus Pinion Puller

position should the pinion be worn. A 1.16-in. shoulder is provided at the back of the inside cylinder which furnishes the bearing against which the teeth rest in the removing process.

The yoke is of cast steel and is fitted with two 2-in. x 8½-in. stud bolts, which screw into lugs provided on the sections of the pulling ring. The liberal length of these bolts permits of the adjustment of the yoke to the proper working position. A section of shafting of sufficient length to permit the pinion to be removed from the shaft with one application of the puller is inserted between the yoke and the armature. This furnishes a bearing for the yoke on the armature shaft and permits the two bolts which clamp the yoke to the pulling ring to be tightened to a point where the pinion is forced from the shaft.

The Pennsylvania Railroad System has issued a report showing that on Dec. 31, 1911, it had 25,236.5 miles of track, the greatest in the history of the company. It was also made public on March 25 that the number of stockholders of the Pennsylvania Railroad on March 1 was 73,567, showing an increase of 7744 over last year. This number does not include the stockholders of the various subsidiaries.

Some Tests of Brakeshoes

Four Types of Brakeshoes Were Tested on the Brooklyn Rapid Transit System to Learn Their Relative Efficiency and Cost—The Final Result Was Determined by Their Effect on Wheel Wear

BY GEORGE L. FOWLER, CONSULTING ENGINEER, NEW YORK

During the past year it has been my privilege to make a rather extensive investigation, under the auspices of W. G. Gove, superintendent of equipment Brooklyn Rapid Transit Company, into the qualities of certain brakeshoes, from many points of view. Four types of shoes were entered in these tests and they will be designated as *A*, *B*, *C* and *D*. *A* was a plain, hard cast-iron shoe; *B* was a cast-iron shoe with the ends chilled; *C* was of cast iron with an expanded metal filling, and *D* was of cast iron with chilled iron inserts in the part bearing on the tread. All shoes were fitted with steel backs and were of the flanged type and each shoe weighed about 21 lb. except the *A* shoes, which weighed about 25¼ lb. each.

The investigation was so conducted as to bring out the qualities of the metal composing the various shoes as well as their own durability and their effect on the wheels to which they were applied.

In the investigation as to the quality of the metal, transverse test pieces were cut from the body of the shoe to obtain the strength of the metal; sections were cut out for the determination of the hardness; chemical analyses were made of the metal, and the structure was examined under the microscope. Sample shoes of each kind were placed upon the brakeshoe testing machine, where the coefficients of friction were determined as well as the amount of metal worn off by the application of the shoe to the wheel.

In the service tests of the shoes the work was done under surface cars where both hand and air power were used as a means of brake application. In this the wear of both shoes and wheels was measured, together with the mileage obtained.

And here attention may be called to the desirability of using shoes wherein the range of individual weight is as low as possible. If, as in the case of the *A* shoes, the weights are raised, the percentage of scrap is of course reduced, but the shoes are so thick that it is difficult to apply them, and the waste of labor in making such renewal applications is greater than the saving resulting from the decrease in scrap percentages. In addition, there is the unavoidable dragging of the shoes on the wheels when they are new, which involves a waste of power.

With steel backs which hold the shoes in shape even when the metal of which they are composed is broken, there may be some doubt as to the necessity of using so strong a metal as that required when the integrity of the shoe depended upon its own inherent strength. In the tests under consideration there was a wide range in the transverse strength of the cast iron of which they were composed. Based upon tests made upon specimens 1 in. square and carried on supports 12 in. between centers, the breaking load varied from 1800 to 3300 lb. There was, however, no disintegration or trouble with the weaker metal in service, so that no evidence was obtained as to the value of strength in the cast iron of a brakeshoe that is furnished with a steel back and is used with the comparatively light pressure and low speeds of city street railway service.

HARDNESS

The hardness of the shoe is usually regarded as a matter of considerable importance, for the harder the shoe the greater its durability. In the case before us there was not much variation in the hardness of the gray metal of the *A*, *C* and *D* shoes, which stood at from 166 to 187 of the Brinnell scale, but the *B* shoes with chilled ends were 269, a condition which, in combination with the chilled ends, goes far to explain the greater wearing qualities shown by these shoes. These are average figures, but even in the examination of the few test pieces considerable variation in hardness was found in each shoe. Attention is called to this because of its probable influence upon the wearing and frictional qualities of the shoes. It is probable that could the shoes be carefully examined in detail it would appear that many of the vagaries that appeared in the durability of the shoes in service might be explained by the variations in the hardness and texture of the shoes, not only between individual shoes but also between different parts of the same shoe. The records show that on some cars a shoe would wear out after a very short mileage, while the next shoe would make a phenomenal record under the same weather conditions and upon the same runs, and that the uneven wear of shoes in the same positions and with unchanged brake rigging may be explained in the same way.

It is, of course, impracticable to draw up any specification that will cover this ground and be commercially workable, but it will be well to call the attention of manufacturers to the desirability of producing a uniform product and of so regulating their foundry practice that the variations in the texture and hardness of the brakeshoe metals shall be reduced to a minimum.

From the limited number and types of shoes used in these tests it is impossible to decide as to what may be the best degree of hardness to adopt, but with this understanding it seems that satisfactory results may be expected with a hardness of about 275 of the Brinnell scale.

CHEMICAL ANALYSIS

Although the chemical analysis of a brakeshoe is a matter of slight importance to a railroad company, analyses were made of all of these shoes for the purpose of throwing as much light as possible on the phenomena which they manifested. We found, for example, that, in the case of the *A* and *B* shoes, the carbon determinations were:

Type of Shoe	Combined Carbon	Graphitic Carbon	Total Carbon
A	1.67	1.36	3.03
B	1.20	1.85	3.05

As shown, the combined carbon in the *A* shoe was much greater than in *B*, yet the *B* shoe was the harder of the two. But the sulphur in *A* was 0.27 per cent as against 0.18 in *B* and this high sulphur content explains the reasons for the high percentage of combined carbon and the lower transverse strength of the test piece. "The presence of sulphur in cast iron tends to cause the carbon to assume the combined form and thus produce a weak and brittle metal." It is also well known that foundry iron of good quality should not contain more than 0.15 per cent of sulphur. So while the chemical analysis may serve to explain some of the physical phenomena manifested by the shoes, it would not be advisable to introduce any chemical requirements into brakeshoe specifications.

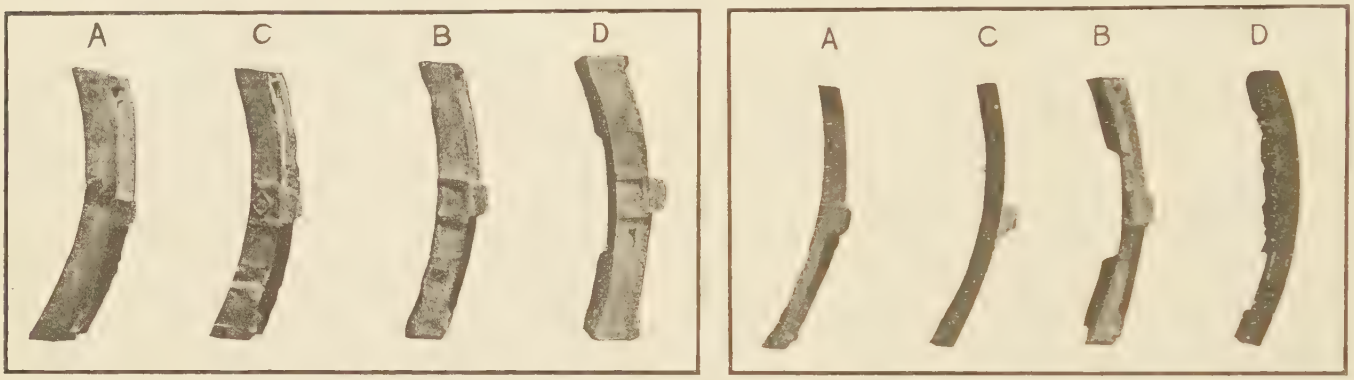
MICROSCOPIC EXAMINATION

A microscopic examinaton of the metal of the two shoes served at least to suggest some of the reasons for their behavior. The *B* shoe, carrying 1.20 per cent of combined carbon, would probably be classified as mottled iron. It, however, differs from the typical mottled iron in the more even balance of the pearlite and the graphitic carbon by which the structure more nearly resembles that of the hard iron.

In the case of the *A* brakeshoe, on the other hand, we find a structure that seems to be a cross between malleable iron and the gray cast iron in that the graphite appears both as flakes and as nodules, but where the flakes do occur they are very much smaller. This difference in structure may explain the fact of the shoe with the lower combined carbon being the harder, as well as the higher coefficient of friction of the *A* as compared with the *B* shoe.

These structures also indicate their connection with the wearing quality of the shoe. The *A* shoe with its resemblance to a malleable structure with the cleavage lines of small graphite particles would tend to wear more rapidly than the *B* shoe, with its closely granular structure, and this was found to be the case both on the testing machine and in service.

The point which I wish to emphasize in this connection is the close relationship that exists between the structure of the metal of a brakeshoe and its wearing and frictional qualities. The average total carbon content of cast iron may be taken at about 3 per cent. It seems, from the working of the shoes of this test, that the best results will be obtained if the foundry practice is such that the two classes of carbon, combined and graphitic, are about balanced, and that the graphitic is scattered through the mass in exceedingly fine particles so that the structure is closely granular and resembles the harder iron as nearly as possible.



Brooklyn Brakeshoe Test—New and Worn Brakeshoes

BRAKING EFFICIENCY

The braking efficiency of each type of shoe was measured in two ways: by the application of the shoe to a wheel in a brakeshoe testing machine and by the measurement of the distance required to stop a car running at various speeds upon a straight and approximately level track.

The tests on the machine at a speed of 20 m.p.h. and a brakeshoe pressure of 6840 lb. gave the results shown in Table I.

Table I.—Showing Characteristics of Shoes as Regards Coefficient of Friction and Wear

Type of Shoe	Coefficient of Friction	Wear per 100,000,000 Foot-lbs.
A	39.8 per cent	1.79
B	31.2 " "	.61
C	41.9 " "	1.83
D	29.1 " "	.47

From this it appears that, so far as the coefficient of friction is concerned, and, with it, the stopping qualities of the shoe, the four stand in the following order: *C, A, B, D.*

This is the unvarying sequence in all of the stops and represents the frictional relationship existing between these four types of shoes when constant conditions are maintained as to surfaces and temperatures, which can be done in the laboratory.

In order to check these results and ascertain whether the coefficient of friction, as determined on the machine with the relative stopping qualities, would hold on the road, a series of tests were made with cars equipped with the four shoes respectively.

ROAD TESTS

To make these tests four cars were equipped with the brakeshoes to be tested, each car being equipped throughout with the shoes assigned to it. The car was of the four-motor type, fitted with air brakes. The cars were put into regular service until all of the shoes were worn down to a full bearing on the wheel, after which a series of test stops were made on a straight and nearly level piece of track.

These tests were as follows: For each of the speeds of 5, 10, 15 and 20 m.p.h. the brake was applied at least three times, in service and emergency application, with the car empty except for the operators. Of these there were always four; and when the car was weighed either empty or loaded these men were on the car. After the tests made with the empty car it was loaded with about 7250 lb. of sand bags to represent a full load of passengers. The average weight of the empty car was 52,197 lb. and of the loaded car 59,750 lb.

The same number of stops, and in the same sequence, were made with the loaded as with the unloaded cars. The cars were equipped with Westinghouse straight-air brakes, type S X brake valves, 8-in. brake cylinders and American slack adjuster set for a 5-in. piston travel. The electric pump governors were adjusted to cut out at 70 lb. in the main reservoir and to cut in at 55 lb., though, as a matter of fact, when the reservoir pressure was reduced to 60 lb. brake applications were made standing so as further to reduce the pressure to the cutting-in point when it was pumped up.

The brakes were all in good order and the foundation rigging was so adjusted that an air pressure of 65 lb. in the brake cylinder, which may be taken as an average of those obtained, put a shoe pressure of about 5100 lb. on each wheel. This gave a shoe pressure of about 78 per cent for the empty and 68 per cent for the loaded cars. There was practically no difference in the braking power of the several cars, though it was somewhat less than that for which the car was designed. These percentages were, however, high enough to cause considerable skidding, especially when an emergency application was made.

The weather conditions were practically constant during all of the tests. It was fair and dry and the rails were dry, though somewhat dirty from the street traffic.

The method of conducting the tests in detail was this: The car was run with an accelerated speed until it had reached one somewhat in excess of that from which it was desired to make the stop. One bell was rung and the motorman shut off his current. The car was then allowed to drift until the speed had fallen to exactly that desired, when a second bell was rung and the motorman applied the brake in service or emergency, according to the test, and allowed the handle to remain in that position until the car stopped. At least three stops were made with each car under the following schedule from each of the speeds of 5, 10, 15 and 20 m.p.h.: Car light, emergency application; car light, service application; car loaded, emergency application; car loaded, service application. So that at least twelve stops were made at each speed and at least forty-eight stops with each car.

It was found that these stops did not quite check with the

laboratory tests, but the variations were so slight that the probability is that they were due to differences in the internal resistances of the cars rather than to variations in the frictional properties of the brakeshoes.

EMERGENCY TESTS

When an emergency application was made the wheels were frequently skidded, with the result that some of the emergency stops were not as good as the service stops of the same class of service. Taking an average of all of the cars it appears that as the speed was increased the emergency application became increasingly deficient as a means of effecting a quick stop with a light car. This obtains to an extent even with the loaded cars, where in four instances the service stops averaged a shorter distance than the emergency. It would appear, therefore, that except where the cars are loaded to capacity the use of an emergency application of the brakes may be of questionable advisability, although when we take the average of all stops of loaded and light cars those with the emergency application are shorter than those with the service.

SPEED OF STOPS

In these tests there were variations in the distances required to make stops from the same speed with same shoe, and it was found that the best stops with any one shoe were better than the poorest stops with any other shoe. This indicates that it is impossible to state in advance that any particular shoe of those tested will make a better or a worse stop than one of the others.

When the averages of all stops with light and loaded cars were compared it was found that some shoes were better than others, but the differences were so slight as to be negligible quantities in average street railway service. This is shown in Fig. 1, from which it will be seen that the difference in length of stop between all shoes from 10 to 15 m.p.h. was but 5 ft. and at 20 m.p.h. was less than 20 ft. This leads to the conclusion that within the limits of this test and of ordinary street railway service where the speeds are less than 20 m.p.h. the coefficient of friction can be disregarded as a matter of safety and especially for ordinary schedule work.

This is emphasized by Fig. 2, which shows the best and poorest stops made with the plain cast-iron shoe. As shown, the variations with this one shoe, under as nearly constant conditions as could be obtained on the road, were greater than the variations between averages of all the different shoes. Thus at 5 m.p.h. the variation with the cast-iron shoe was 5.25 ft., at 10 m.p.h. it was 16.50 ft., at 15 m.p.h. it was 27.75 ft. and at 20 m.p.h. it was 45.5 ft. Similar variations were found with the other shoes, and the value of the diagram is that it shows the limits within which it may be expected that a car with an air brake may be stopped under the conditions of car and track which existed at the test, and these conditions were those usually found on a street railway. But let the conditions of track or car change and straightway there will be a change in the distance in which a car can be stopped.

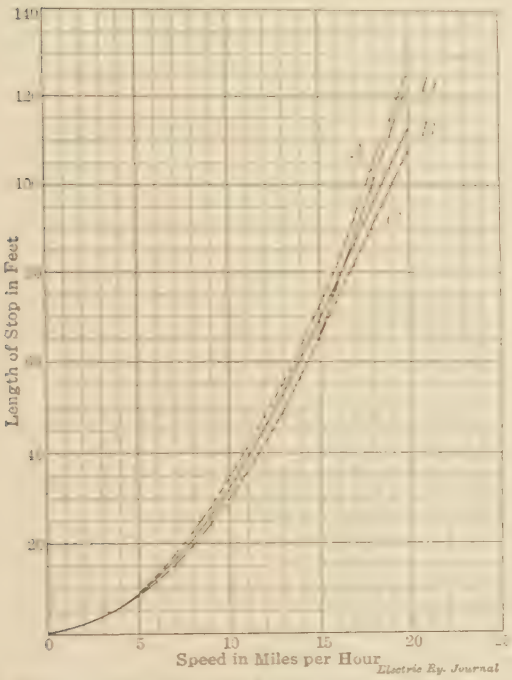


Fig. 1—Brooklyn Brakeshoe Test—Diagram of Averages of All Tests, Light and Loaded Cars for Various Speeds and Lengths of Stop in Feet.

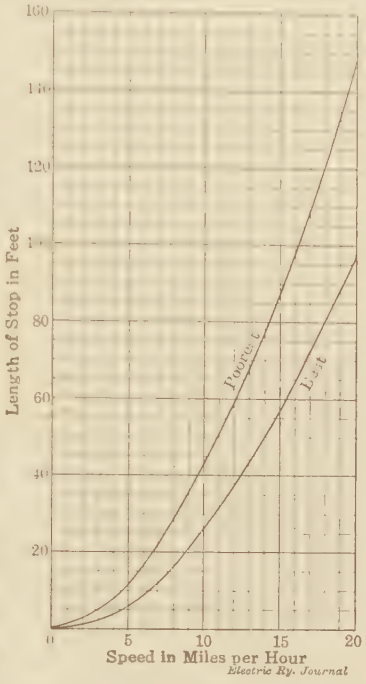


Fig. 2—Brooklyn Brakeshoe Test—Diagram Showing Limits of Best and Poorest Stops, Light and Loaded Cars, with Plain Cast-Iron Brakeshoe on a Dry Rail

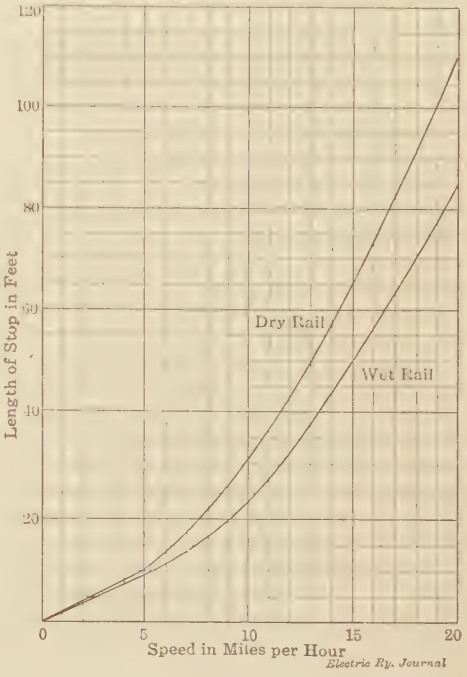


Fig. 3—Brooklyn Brakeshoe Test—Diagram of Averages of All Stops, Light and Loaded Cars, on Dry and Wet Rails, of Cast-Iron Brakeshoes Having Chilled Ends

STOPS ON WET AND DRY RAIL

To show this the tests on the dry rail were duplicated on one that was wet, using the same stretch of track for the purpose. These tests were made with the car fitted with the cast-iron shoes having the chilled ends, and the results are shown in Fig. 3 of the average of all stops with light and loaded cars on dry and wet rails. This shows that a shorter stop can be made on a wet than on a dry rail and that the distance saved averages about 1 ft. at 5 m.p.h., 6 ft. 9 in. at 10 m.p.h., 11 ft. 9 in. at 15 m.p.h. and 16 ft. 6 in. at 20 m.p.h. Hence it will be seen that the effects of varying conditions on the distance required to stop a car are much greater than those which can possibly be produced by a variation in the coefficient of friction of different types of brakeshoes.

This possibility of ignoring the coefficient of friction, within the limits of current practice, put the selection of brakeshoes on a purely commercial basis and leaves us free to consider but two elements in the choice of a brakeshoe, the life of the shoe and the effect of the shoe on the life of the wheel. The rate of wear of the two will determine the economic value of the several types of shoes that were entered in the test. Illustrations of these shoes are presented on page 554.

EXTENT OF TEST

It was recognized that to secure results of any value the tests must be extended over a considerable period of time and that they must cover a fairly wide variety of traffic conditions and be of such volume that local variations from the normal would disappear and have but a minor influence on the general average. To secure these results 200 shoes were obtained of each of the four types to be tested. Each group of 200 shoes received a serial numbering and each shoe of the group received an individual number and was painted with a distinctive group color.

For the purpose of the test thirty cars were selected; twenty were fitted with maximum traction trucks and five each with Baldwin and Peckham double trucks with four-motor equipments. The cars selected represented two different types of car bodies. The distribution of the shoes on these cars was such that each shoe did the same average amount of service. Shoes were put upon all the wheels of the four-motor equipment cars, of which there were five of each, so that there were forty wheels available for the test. On the cars equipped with maximum traction trucks the shoes were put upon the driving wheels only. As there were twenty of these cars, again there were forty wheels available for the test. The shoes were arranged opposite and parallel in groups, so that each type of shoe, so long as it lasted, would be called upon to do the same amount of work and make approximately the same mileage.

Each brakeshoe was weighed before it was applied and again when it was removed. A record was kept of the date of the removal and application of each shoe. Of course new shoes were used to replace only those of the same type that were worn out. The scales used for weighing the shoes had a capacity of 48 lb. and were accurate to 1/16 oz.

In like manner a contour line was drawn with a Bacon tire indicator of the tread and flange of each wheel at the commencement of the test and again when the last brakeshoe applied to that wheel was removed.

The mileage of the cars was obtained from the records of the company, and with the dates of application and removal of each shoe it was possible to obtain the mileage and life of each shoe, as well as of each wheel entering into the test. It is on the basis of this combined information that conclusions have been drawn.

Finally, as to the duration of the test, the first shoes were applied on May 3, 1910, and the last removed was on May 5, 1911. During that year the cars were in regular service and were run according to the orders of the transportation department, without regard to the test, except that the routes of the individual cars were not changed. The results are, therefore, those obtained in a year's service with 800 brakeshoes.

It was found that there were wide variations in the rate of wear of both wheels and brakeshoes on the different cars and routes, the greater portion of it being directly traceable to the differences in the service. Of this the frequency of application of the brakes is an important element, and to ascertain what this might be observations were made on each of the runs as to the number of stops and brake applications for slowing down. They were found to vary but little in any individual run. The average speeds ranged from 6.82 to 8.88 m.p.h. and the stops averaged from 8.48 to 11.35 per mile, the greatest number of stops naturally coinciding with the lowest speed.

WEAR OF SHOES

One of the routes used had a reputation for being particularly hard on shoes. This reputation was in part due to the character of the scrap. On two of the routes the shoes were worn very evenly and the scrap was in good condition, the shoes being worn very much like the halftone view showing new and old shoes of each class in which the wear was uniform throughout the whole length. On the other two routes, on the other hand, the scrap was frequently uneven; that is, the shoes were worn to a thin edge at one end and were thick at the other. This made it necessary to scrap the shoe while there was still metal on it that should be worn away. The weight of scrap in the two sets of cars proves this condition. In one the scrap averaged 38.22 per cent of the original weight of the shoe and in the other but 31.24 per cent. If the weight of a new shoe for this service is taken at 21 lb., about 30 per cent of that weight, or 6.3 lb., is almost the ideal condition of scrap. The cast iron will be nearly all worn away, yet the steel back and enough more remains to do effective braking and protect the head. If, however, the wear is carried down to a scrap weight of 5½ lb. there is danger of wearing the head. With 6.3 lb. as a basis the average lost metal in the shoes having a uniform wear was but about ¼ lb., while in those having the unequal wear it was nearly 1¾ lb. per shoe, or nearly 12 per cent of the weight of the shoe that is available for wear. This extra loss in the scrap fully accounts for the reputation of the division for being hard on shoes and shows how important it is that the foundation brake rigging shall be carefully adjusted so as to obtain an even wear on the shoes if the best and most economical results in the matter of wear are to be obtained.

Fig. 4—Brooklyn Brakeshoe Test—Typical Wheel Tread Wear per 1000 Miles

A comparison of the weights of metal worn away per 1000 wheel miles for the several shoes gave the following proportional results: B = 100, A = 130, D = 141, C = 169.

Taking this wear of brakeshoes on the basis of the actual amount of metal worn away, there was not much difference between the hand-brake and the air-brake cars, though the rate of wear was somewhat more rapid on the air-brake cars. Taken on the basis of the number of pounds worn off per 1000 wheel miles, the results were as shown in Table II.

Table II.—Showing Rate of Brake-shoe Wear in Pounds per 1000 Wheel Miles

Type of Shoe	Hand-Brake Cars	Air-Brake Cars	Average All Surface Cars
A	4.79	4.95	4.88
B	3.65	3.88	3.76
C	5.46	6.95	6.37
D	5.43	5.26	5.33

RATE OF WHEEL WEAR

The rate at which the wheels were worn, all of which were solid steel wheels, based on the miles run per 1/16 in. of radial wheel wear, was as shown in Table III.

Table III.—Showing Mileage of Wheels per 1/16 In. of Radial Wear

Type of Shoe	Hand-Brake Cars	Air-Brake Cars	Average All Surface Cars
A	9892	8197	8931
B	6763	7606	7173
C	8578	7827	7880
D	6848	7846	7433

Again it appears that the rate of wear with the air brake is greater than with the hand, as in the case of the brakeshoes there is one exception to this. It also appears that 1/16 in. radial wear per 8000 miles is a fair average mileage for surface cars engaged in a dense traffic.

Of course the wear of the wheels is not all due to the action of the brakeshoe, but it is fair to assume that that action is responsible for a part of it.

From Table III it will be seen that the best mileage was

obtained with the plain cast-iron *A* shoe. Next came the *C* with expanded metal filling, while the shoes with which the wheel wear was the most rapid were those formed of a combination of soft and chilled cast iron, the *B* and *D* shoes. It appears probable that in these shoes the soft metal is worn away, leaving the edges of the chilled metal to act as cutters on the tread of the wheel.

Fig. 4 shows four of these treads worn to correspond to the average wear after a run of 10,000 miles with each of the shoes tested. These are reproductions of actual diagrams and were selected solely on the basis of the amount of wear, regardless of its character. The black portion in the cut shows the amount of metal worn off. Each diagram shows a remarkably even wear, with no tendency to run to a sharp flange or a built-out flange, and this is characteristic of all of the shoes.

The value of an extensive test in reaching a determination regarding such a matter is evidenced by the wide variations in the mileages required to wear off 1/16 in. from the tread of the wheel. This range was as follows: *A* brakeshoe, 4714 to 15,356 miles; *B* brakeshoe, 3388 to 20,962 miles; *C* brakeshoe, 3434 to 29,734 miles; *D* brakeshoe, 3388 to 20,962 miles.

From this it appears that the variation with the plain cast-iron *A* shoes was less than with any of the others, but whether or not this was due to a greater uniformity in the texture of the shoe there is no means of determining. The averages on all cars do not differ much, and from these tests it appears that the average mileage per 1/16 in. of radial wear is about 8000 miles. With the wear taken at 60 per cent of the total reduction of diameter the life of a steel wheel would be about 153,000 miles.

Based on the amount of metal worn from the shoes on the service tests, the *B* shoe with chilled ends is the most durable, followed by the plain cast iron and then by the one with chilled inserts and last by the one with expanded metal filling. This does not quite agree with the results obtained on the testing machine, where the shoes with chilled inserts showed the greatest durability, although the other shoes were in the order given. As far as the relative durability of the *A* and *B* shoes are concerned, there is a concurrence throughout the laboratory and road tests to the effect that the *B* shoe with chilled ends is more durable than the plain cast-iron *A* shoes.

RELATIVE COSTS

In the calculation of brakeshoe costs it is evident that a difference in cost between shoes presenting different rates of wear will increase as the base price is raised and that it will grow less as the price is reduced.

In connection with the cost of brakeshoes and wheels per 1000 miles the assumption is made that the brakeshoe is responsible for any differences in the rate of wear that may appear. This assumption is based on the correspondence between rate of wheel wear and the shoe applied.

Taking the averages of hand-brake cars and of air-brake cars as well as of all surface cars, the lowest in cost is the *B* brakeshoe, and the order in which they stand is: *B, A, D, C.*

On the basis of first costs the cast-iron *B* brakeshoe with chilled ends cost 8.4 cents less per 1000 car miles than the plain *A* cast-iron shoe on the hand-brake cars and 14.16 cents less on the air-brake cars, while on the basis of an equal number of each the cost would be 12.6 cents less per 1000 car miles. These are not exact ratios but are based on the proportions of mileage actually made by the cars under observation. This is for the brakeshoes alone.

When we come to the wear of the wheels, the wear being greatest on the wheels using the shoe with chilled ends, the relation is changed. In the general average of the shoes on the hand-brake cars the cost of the *B* shoe was 4.31 cents more per 1000 miles than with the *A* shoe. On the air-brake cars it was 1.02 cents more, while for the general average it was 2.6 more. This tends to counterbalance the saving made in brakeshoes, and the tables of the cost of wheel and brakeshoe wear per 1000 car miles show that both in the actual costs as determined by this test and the possible costs as estimated on the basis of an ideal brakeshoe wear there is not much difference between the two shoes.

On the hand-brake cars the plain cast-iron shoe is the cheaper, both on the basis of the test and the possible wear. On the air-brake cars the cost of the *B* shoe with chilled ends is the lower, while in a general average of all surface cars on the basis of an equal number of hand-brake and air-brake cars there is a difference of 4 cents per 1000 car miles in favor of the plain cast-iron *A* shoe, on the actual test, and of 3 cents per 1000 car miles in favor of the *B* shoe, on the basis of an ideal shoe wear, leaving 30 per cent of scrap from a shoe weighing 21 lb. This difference is so slight that on a basis of the prices used very slight change in conditions would tip the balance one way or the other.

There is another point that has a slight bearing on the matter and that is the cost of applying new brakeshoes. With the man's pay at the rate of $2.25 per day it takes about eighteen minutes to apply a brakeshoe to a maximum traction truck and about twelve minutes to apply one to a Baldwin 1-A-5 or a Peckham 25 truck. This puts the cost per shoe at 6.75 cents for the former and 4.50 cents for the latter.

It is evident that the more rapid the wear of the shoes the more it will cost to apply them. On the basis of the wear obtained it will cost 2 cents per 1000 car miles more to apply the *A* than the *B* shoes, or not enough to make a decided difference in favor of one shoe or the other.

In this discussion the *C* and *D* shoes have been disregarded because their first cost is so much in excess of the other shoes that they are not to be considered on the basis of economy of operation.

If, then, the shoes are to be bought on a tonnage basis, the lower priced shoe of these two will be the cheaper. But if they are to be bought on the basis of brakeshoe cost alone per 1000 car miles on a guaranteed price, then the price of the *B* shoe should be very materially less than that of the *A* shoe.

That is, if the brakeshoes were to be bought at any guaranteed price per 1000 car miles, whether 25 or 50 cents, such a plan would remove all distinctions between shoes and put all on the same basis so far as the railroad is concerned. It is a matter of no moment whatever how rapidly they wear, except for the cost of the labor of replacement. The whole interest then centers on the rate of wheel wear or the effect of the brakeshoe on the wheel, and, other things being equal, it is the shoe causing the rapid wheel wear that is the most expensive one to use. And this excess may amount to from 30 to 50 per cent of the guaranteed cost per 1000 car miles. Evidently this is a serious matter and one to which especial attention should be paid in the selection of the shoe that is to be used.

The estimate on this basis shows a difference of over 18 cents. But if this were to be cut in two and the difference be made but 9 cents the indications are that the balance would be in favor of the *A* shoe. On the other hand, if the *C* shoe were to be bought on a basis of mileage guarantee it would be possible to pay more for it than for the *B* shoe, while the *A* shoe would still have an advantage over it.

CONCLUSIONS

As a result of this investigation the following conclusions were reached:

In order to avoid excessive costs for the application of brakeshoes the weight should be limited so that no individual shoe should weigh more than 24 lb. To avoid an excessive loss of weight in the percentage of scrap the minimum weight of individual brakeshoes should be 20 lb.

There appears to be a close relationship between the microscopical structure of cast iron and its wearing quali-

ties. Hence the foundry practice should be such as to secure a structure that is closely granular, of uniform texture and with the combined and graphitic carbon pretty evenly balanced. The graphitic carbon should be in the form of nodules rather than flakes.

There is a general relationship between the coefficient of friction as determined on the testing machine and the stopping qualities of a brakeshoe in service.

The greater value of the emergency application of the air brake as compared with the service is merely that of greater rapidity of application.

As far as the safety of a car is concerned, owing to the ability to stop from the speeds common in surface-car service, there is no appreciable difference between any of the shoes tested. The extreme variation at 15 m.p.h. averages but 5 ft., or about 7.7 per cent. At 20 m.p.h. it is but 17½ ft., or 16.26 per cent. At lower speeds the difference is correspondingly less.

A clean wet rail presents better facilities for stopping than a dry rail, the difference being about 30 per cent in favor of the wet rail.

Brakeshoe wear averages from 3.75 lb. to 6.5 lb. per 1000 wheel miles. The scrap weights of brakeshoes on the surface lines should not be allowed to drop below 6¼ lb. per shoe. When the scrap weight has reached 5½ lb. there is danger of cutting the head. The ideal scrap weight is 30 per cent of the original weight.

Shoes containing chilled cast iron either integrally or in the form of inserts wear steel wheels more rapidly than those of gray cast iron only. The order of wear of the wheels with the shoes submitted in the total averages of mileage per 1/16 in. of wear is: *A*, 100; *C*, 88.23; *D*, 83.23; *B*, 80.32.

The wear of shoes is largely dependent on the character of the foundation brake rigging and the way in which it is maintained.

There is a wide range of mileage obtained with individual shoes of the same type.

A steel wheel will run about 8000 miles per 1/16-in. wear in surface work.

The cost of brakeshoes only per 1000 car miles is least for the cast-iron *B* brakeshoes with chilled ends.

The combination of brakeshoe and wheel costs per 1000 car miles places the *A* and *B* brakeshoes about on a par.

If the price is based on the cost of brakeshoes per 1000 car miles, a higher price can be paid for the plain cast-iron *A* brakeshoe than for one with chilled ends, because of the decreased cost of wheel wear.

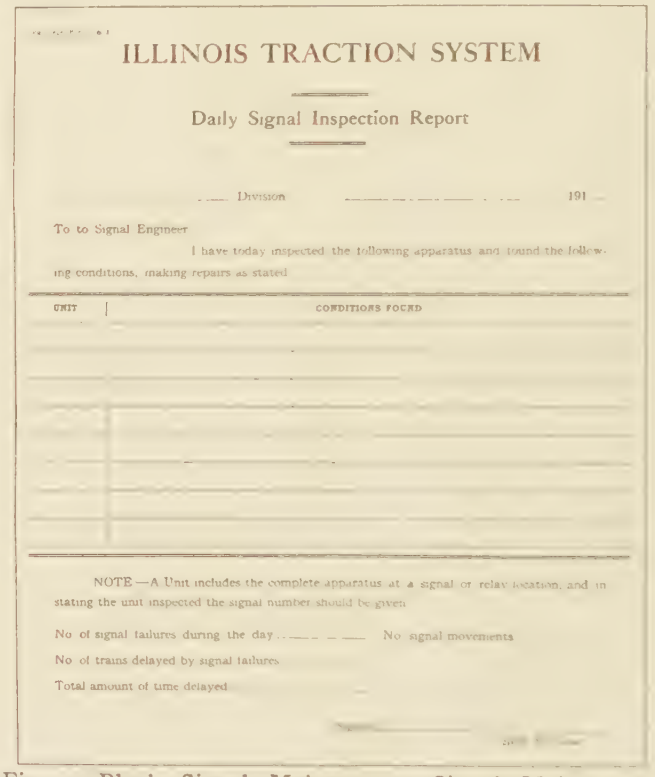
Finally, the test corroborates the well-known fact that hardness and durability of brakeshoes go hand in hand. But it especially emphasizes the importance, where steel wheels are used, of considering both the wear of the wheel and the wear of the shoe, for the fact is forced well to the front that a shoe may be very economical in itself and yet have such a severe effect upon the wheel that when both wheel and shoe wear are taken together the result may be the reverse of economical.

The Bureau of Manufactures, Washington, D. C., is preparing a 56-page bulletin, "Factors in Foreign Trade," that will be of great assistance to manufacturers and others interested in broadening their foreign trade. This bulletin will contain answers to such questions as "What language is best to use?" "In what currency and in what units of weights and measures should prices be quoted?" "What postage should be placed on the catalogs or the letters?" Conversion tables of all kinds show readily such data as the equivalent price per meter in Mexican currency of cloth quoted at 50 cents per yard in United States currency. Summaries of foreign postal rates are also given. Those who desire copies of the bulletin should apply to the Bureau of Manufactures, Department of Commerce and Labor, Washington.

BLOCK SIGNAL PERFORMANCE AND MAINTENANCE ON THE ILLINOIS TRACTION SYSTEM

During the past year the Illinois Traction System has completed the installation of 155 automatic track-circuit-controlled block signals for the protection of 82.3 miles of single track. In an article by John Leisenring, signal engineer Illinois Traction System, the plan of signal protection, details of installation and the operating features of the large installation were described and illustrated in this paper on page 1105 of the issue for June 24, 1911. The early performance records of these signals, which were supplied by the Union Switch & Signal Company, were presented in the issue of Sept. 2, 1911, page 398.

Since the earlier articles appeared the care of the high-tension and direct-current lines has been put in charge of the signal engineer, and the organization has been put on a maintenance basis. The following information, which has been supplied by Mr. Leisenring, illustrates the high degree of operating performance which was obtained from



ILLINOIS TRACTION SYSTEM

Daily Signal Inspection Report

____ Division _____ 191 __

To to Signal Engineer

I have today inspected the following apparatus and found the following conditions, making repairs as stated

UNIT	CONDITIONS FOUND

NOTE—A Unit includes the complete apparatus at a signal or relay location, and in stating the unit inspected the signal number should be given

No of signal failures during the day _____ No signal movements

No of trains delayed by signal failures

Total amount of time delayed

Fig. 1—Block Signal Maintenance—Signal Maintenance Daily Report

this signal installation through the fall and winter months, a period during which several unusually severe wind and sleet storms were experienced. In connection with the accompanying table, showing the signal performance from September to January inclusive, the use of the expression "signal failure" is a misnomer. It is a term that has been used by signal engineers to denote that a signal has not performed the operation which the observer thought it should perform. For example, in the table are noted records of "failures" and "creditable failures." The "failures" were all on the safe side; that is to say, any derangement of the signal system caused a stop signal to be displayed, and the "failure" might have been caused by such things as loss of power, lightning burnouts, blown fuses, apparatus damaged by external causes and cars in the block. The latter failure would be called a "creditable failure," because, although the motorman of a car held by a signal to "stop" would report that signal, the signal was doing its full duty in protecting another car in the next block. The accompanying table presents separately the signal performance data for each of five months.

The continuity of service obtained is clearly shown by the statement that there were but 185 "failures" in 919,578 movements (99.979 per cent perfect), and that of the 185 "failures" 138 were either "creditable failures" or charge-

Sig. Dept. Form No 3

No. 700

Date .....

Time .....

Unit .....

Sig. No. .....

No. 700

Return this Card to Signal Engineer as soon as found, giving below condition of apparatus.

Fig. 2—Block Signal Maintenance—Card for Surprise Checking Signal Maintainers

able to other departments than that for which the signal engineer is responsible. Of the failures chargeable to

"Signal Department"—One was caused by a mouse nest in the gear, one by low track voltage, three by motor brushes out of adjustment, one by dirty commutator and eight by bad order insulated joints.

"Blown Fuse"—Ten were caused by lightning.

Performance of Automatic Block Signals

	Sept.	Oct.	Nov.	Dec.	Jan.	5 Mos.
No. of signals.....	122	124	124	124	155	129.8
No. of movements....	158,433	188,800	178,588	193,778	199,979	919,578
No. of failures.....	30	30	42	34	49	185
No. of trains stopped.	38	37	62	52	58	247
Minutes delayed	125	124	205	156	147	757
Movements per failure	5,281	6,293	4,252	5,699	4,081	4,970.7
Movements per train stopped	4,169	5,102	2,880	3,726	3,448	3,723
Movements per minute delayed	1,267	1,522	871	1,242	1,360	1,214.7
Per cent	99.98	99.97	99.98	99.98	99.97	99.98

Signal Failures Chargeable to

Signal department.....	1	5	1	3	5	15
Blown fuse	10	12	13	8	6	49
Defective apparatus...	2	..	..	..	3	5
Track department	1	2	..	1	9	13
Bad track rail bonds.	..	..	7	9	6	22
Power department ...	12	2	7	4	1	26
Overhead department..	2	2	4	1	..	9
Operating department.	..	2	4	2	..	8
Broken wire	1	1	5	6	14	27
Miscellaneous	1	..	..	..	..	1
Creditable failures.....	..	4	2	..	5	11

"Defective Apparatus"—Two were caused by open coil in motors and one by motor in bad order.

"Track Department"—Three were caused by trackmen shunting track, one by unauthorized movement of switch box and one by damaged insulated joint.

"Power Department"—Fourteen were caused by power off, seven by weak power and three by breakers out.

Sig. Dept. Form No. 2

ILLINOIS TRACTION SYSTEM

REPORT OF SIGNAL FAILURE

Location ..... Date .....

To Signal Engineer, Dispatcher: Time.....M

Train No. ..... M.

Signal No.....at Stop. Signal No.....at Caution.

Cause of Failure.....Light Out at Signal No.....

Time Delayed.....min. Did Signal Clear before you proceeded?.....

Signed ..... Motorman

Fig. 3—Block Signal Maintenance—Motorman's Report of Signal Failure

"Overhead Department"—Four were caused by guys down on signal wires, four by broken wires and one by wire swinging into the signal line.

"Operating Department"—One was caused by car hitting switch box and four by trolley hitting the signal wires.

"Bonding Department"—Twenty-two were caused by broken bonding on rail joints.

"Miscellaneous"—One was caused by relay burned by lightning.

"Creditable Failures"—Nine were caused by cars in blocks, one by car not being in clear at siding and one by broken rail.

SIGNAL MAINTENANCE

There are four maintainers, with headquarters at the following points: Division 1 at Morton, division 2 at Springfield, division 3 at Danville, division 4 at Gillespie. The characteristics of the different divisions are as follows:

Division 1—Forty-three signals, 21 miles of signal territory, 41.5 miles of territory covered.

Division 2—Twenty-nine signals, 1.9 miles of signal territory, 95.2 miles of territory covered.

Division 3—Eighteen semaphore signals, ten light distance signals, 9.3 miles of signal territory, 62.7 miles of territory covered.

Division 4—Seventy-three signals, 38.1 miles of signal territory, 56.4 miles of territory covered.

The maintainer on division 1 does light telephone maintenance as well as signal maintenance; those on divisions 2 and 3 maintain telephones and Blake dispatchers' signals as well as automatic signals, while the maintainer on division 4 does nothing but maintain the automatic signals. The men are subject to call at any time during the twenty-four hours, and are supposed to cover their entire territories at least twice a week, sending in to the signal engineer's office daily reports (Fig. 1) of the work done and conditions found. On these reports are shown the number of signal movements during the day, the number of failures, if any, the number of trains delayed and the amount of time delayed. Maintainers are instructed to call the dispatcher of the division on which they are working at least once an hour and advise him where they are. They also report direct to the signal engineer's office three times a day.

Trainmen are provided with blanks (Fig. 3) which they are instructed to make out at the end of each run, provided there have been any failures during the run. One copy of this form is sent to the dispatcher and one to the signal engineer's office. The dispatcher is notified by the crew of any train stopped by a signal, and an order is given on the regular form before the train is allowed to proceed, but these reports are made out in addition to the telephone report. The signal maintainers make out a report (Fig. 4) for each signal failure cleared. These blanks are reproduced herewith, together with a form (Fig. 2) used by the signal engineer or any inspector. This form shows the

Sig. Dept. Form No. 4

ILLINOIS TRACTION SYSTEM

REPORT OF SIGNAL FAILURES CLEARED

Location ..... Date ..... Signal No. .....

Time Reported ..... M. Time arrival at Signal ..... M.

Time Received ..... M. Time Repaired..... M.

Reported by..... Time Reported Clear .....

Total Time Out of Order ..... Repaired by .....

Cause of Failure .....

Fig. 4—Block Signal Maintenance—Report of Signal Failures Cleared by Maintainer

regularity with which the maintainers cover their divisions. One of these forms is placed in a piece of apparatus without the maintainer's knowledge, the stub being retained in the book for reference as to the amount of time that expires before the detached portion is returned.

The New Carhouse and Line Department Building of the Rockford & Interurban Railway

A Description of a Modern Fireproof Minor Repair Shop Building and Equipment—Also Describes New Trainmen's Club Rooms and Overhead Line Department Organization and Headquarters

The Rockford & Interurban Railway Company, Rockford, Ill., has recently completed a carhouse at Rockford which is a good example of modern fireproof building construction. This company operates 107 miles of track, which include an interurban road connecting Rockford with Freeport, Ill., and Beloit and Janesville, Wis., and the city lines at Rockford, Beloit and Janesville. All minor repair work to the interurban cars, as well as the cars operated on the Rockford street railway system, will be done at the new carhouse. The company also recently completed a shop where the heavier repair work is handled, as described in the Electric Railway Journal for Sept. 2, 1911, page 382.

The property on which the new building and storage yard have been constructed is located at the corner of First Avenue and Kishwaukee Street, just outside the business district of Rockford. This central location materially reduces the amount of time consumed in replacing cars in bad order with equipment in first class condition. The general layout includes a building approximately 64 ft. x 224 ft. in plan, with an ell at the rear end, 32 ft. x 99 ft. in plan, which contains the boiler room, storage bins for coal used in the heating plant and on the cars, an oil-storage room, a small stockroom containing running repair parts and the repair shop.

Four tracks have been extended from the street into the building, and as soon as the old carhouse, which is located on a lot adjoining the one on which the new building was constructed, can be torn down six tracks for car-storage purposes will be constructed on the vacated property. The front of the building has been set back 40 ft. from the street line in order to provide a space in front of the building where cars can be held temporarily without blocking the street or sidewalk. The storage capacity of the barn is approximately twenty cars, and as soon as a yard is completed the total storage capacity will be increased to sixty-five cars. The area between the curb line and the face of the building has been paved with brick. The overhead trolley lines will be supported from poles located at the curb line and eyebolts embedded in the reinforced concrete columns in the carhouse. This method of suspension leaves the yard entirely clear of poles, which is very desirable.

The building is constructed wholly of brick and reinforced concrete. The monolithic concrete foundations support a reinforced concrete superstructure, which consists of 16-in. columns spaced at 16-ft. intervals longitudinally and with 30-ft. 4-in. and 32-ft. 4-in. spacing across the building at the rear. Under the two-story portion two rows of columns have been added, which reduce the spans one-half. The second story and roof are carried on heavily reinforced concrete girders 28 in. deep by 16 in. thick.

The roof is constructed of a 6-in. reinforced concrete slab, supported on the concrete girders and columns and on the brick walls between the girders. The roof covering is five-ply tar and gravel, and drainage is provided on both sides of the building. In order to keep the roof drainage off adjoining property on the north and at the same time not waste space which could be used for building purposes, the down spouts were carried down on the inside of the wall.

The outside walls are 13 in. thick and are built of common brick faced with a dark red pressed brick laid in mortar colored black. All openings are provided with reinforced concrete sills and lintels. The architectural treatment of the buiding is rather plain. The walls are paneled on the outside with 24-in. brick pilasters spaced at 16-ft. intervals. The tops of the walls have been corbeled out to give a slight overhang, and the wall on the front of the building, which is two stories, has been allowed to project 3½ ft. above the roof so as to give it a more imposing appearance. All partition walls, except those surrounding the coal bins, have been constructed of 6-in. fireproof hollow tile.

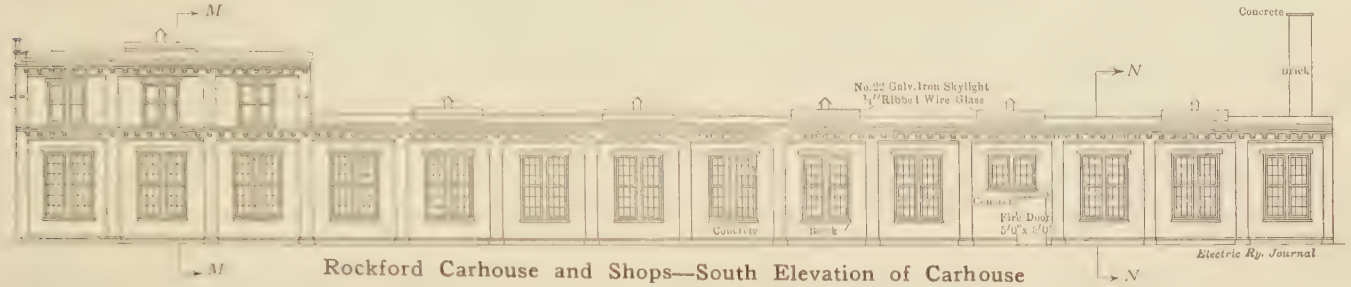
All the openings in the partitions have been provided with underwriters' specification tin-clad doors which close automatically. The four entrances to the track bays have been supplied with manually operated corrugated rolling doors. A short section of trolley runway made of oak has been applied to the lower flange of each door, which when the door is elevated fits between the ends of the trolley wire on either side of the door opening. The wooden trolley section is so applied that it strikes the lintel over the door opening, which furnishes a solid bearing and adjusts it to line and surface with the trolley wire. Although the construction is very simple and the cost practically nothing, the device seems to do the work for which it was built without requiring any attention.

Rockford Carhouse and Shops—Front View of Carhouse

Since the source of natural light was partially cut off in the north wall, it was necessary to install a number of large skylights in addition to the large twin windows in the rear and south walls of the building. There are thirteen 6-ft. x 12-ft. skylights and six smaller skylight openings provided in the reinforced concrete roof. These are spaced at proper intervals to furnish the most uniform distribution of light. The skylights are constructed with sheet-metal frames and glazed with wire glass. Each skylight is surmounted with a 14-in. ventilator. All the walls and ceilings of the carhouse were painted with white cold-water paint. Since the lower portion of the walls would become soiled in a very short time, they were painted a dark green for 5 ft. up.

All floors in the carhouse except those on the second floor are of concrete sidewalk construction and 6 in. thick. The floor over the north track in the building has been sloped to drain between the rails so that this track could be used for washing cars. Three pits extending the full

length of the building have been constructed under the three south tracks, a cross-section of which is shown in the illustration. The pit nearest the shop space has been provided with a wheel drop pit and hoist of novel construction. The two sections of rail in the hoist are carried on a support attached to the lower ends of the elongated stems of



Rockford Carhouse and Shops—South Elevation of Carhouse

two Buda 19-B type ratchet jacks. These jacks are permanently located on each side of the car pit and at the general floor level. This arrangement permits a pair of wheels to be manually lowered or raised by two men, and the whole installation has been made at a very reasonable cost.

In order to facilitate the handling of armatures and repair parts from the four tracks in the main building to the repair shop, a 2-ton overhead Shepard electric traveling hoist has been installed. This hoist is supported on a 10-in. I-beam bolted into a reinforced concrete beam constructed for the express purpose, and travels the full width of the building.

As the repair work at this shop includes only minor repairs, a complete shop equipment was unnecessary. The installation consists of a Buffalo forge, a pair of emery wheels, a shaper, a drill press and lathe. The oil-storage room has been provided with Bowser self-measuring oil tanks. The outfit consists of one four-barrel tank and three two-barrel tanks. The coal storage bins are of sufficient size to store two cars of coal each.

TRAINMEN'S CLUB ROOMS

The front portion of the building is two stories in height, and the second floor, which is 48 ft. x 65 ft., is occupied by the trainmen's club rooms. The general arrangement includes a large room used for a lounging and an assembly room, a reading room, a locker room and a large room containing shower baths and toilet facilities. The fireproof construction was carried out in this section of the building by constructing the floors of reinforced concrete and surfacing them with matched maple flooring in the assembly and reading rooms. The locked room is provided with fireproof sheet-metal Lyon lockers, and the floors in this room and the bathroom are of concrete.

The finish in the club room is yellow pine stained a light brown and varnished, leaving a flat finish. All hardware is of a bronze finish. The walls have been painted dark brown and the ceilings a light buff. This finish, as a whole, when combined with the "Mission" style furniture in weathered oak, gives a very pleasing general appearance. A magazine rack has been placed in the reading room, where a number of trade journals as well as popular periodicals of fiction may be found at all times. The club rooms are under the supervision of the superintendent of transportation, and their maintenance is borne by the railway company. All trainmen have been provided with a key to the room, and a janitor is on hand at all times.

Rockford Carhouse and Shops—Overhead Line Department Building

Rockford Carhouse and Shops—View of Employees' Club Rooms

LIGHTING AND HEATING SYSTEMS

The lighting for the carhouse and shops was obtained from 150-watt, 110-volt a. c. "Maxilights" in the ceiling. These are spaced at sufficiently close intervals to provide ample light on the floor and in the open pits. The lighting system is carried in sherardized conduits which were embedded in the concrete roof slabs during construction. Three "Maxilights" have been installed in old arc-lamp fixtures supported on ornamental iron brackets on the front of the building. The whole lighting system is controlled from a central switch and two individual cut-out cabinets were installed, one for controlling the club rooms and the other for the rest of the building.

The heating plant consists of a 54-in. x 16-ft. 6-in. Kewanee horizontal boiler installed in a room provided at the rear end of the building. The plant is operated on a low-pressure vacuum-return basis, with all feed pipes and radiation in the carhouse portion carried on hangers embedded in the reinforced concrete beams which support the roof slab. The Van Auken system of vacuum return was used, which included Belvac Thermofier traps for each set of coils. The radiation in the carhouse portion is of the branch-tee coil construction, and Colonial type radiators have been installed in the club rooms on the second floor. Sufficient radiation was provided to maintain a temperature of 70 deg. in the club rooms and 50 deg. in the carhouse proper when the temperature outside is 10 deg. below zero.

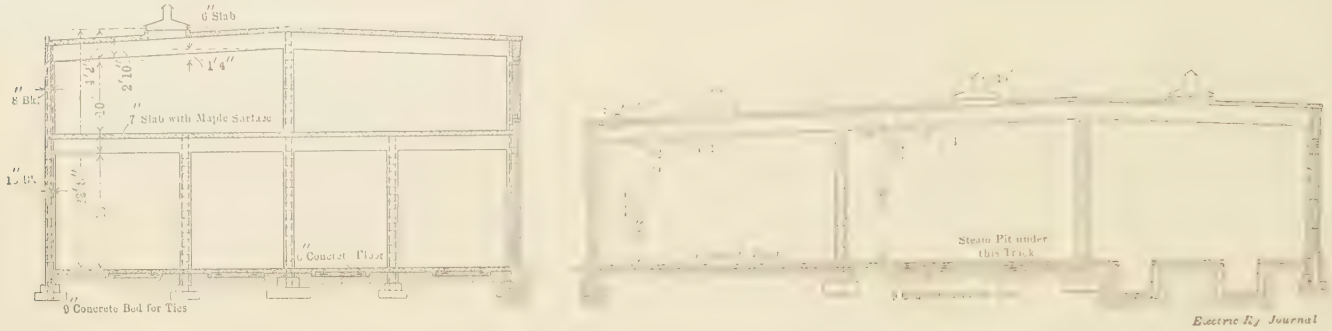
The carhouse and storage yards were designed by W. S. Hubbard, chief engineer for the company, under the supervision of W. C. Sparks, general manager. The approximate cost of the complete improvement was $35,000.

NEW LINE DEPARTMENT BUILDING

At the same time that the carhouse was constructed property 66 ft. wide by 160 ft. long was acquired across the street from the car storage yard, which was used as a location of the overhead department building and storage yard. Although the complete layout required an expenditure of only $2,500, the unusual thing about it is that even this amount of money should be spent for a headquarters for the overhead department. Any quarters for the overhead department, other than a corner of the storeroom or shop or a location undesirable for any other purpose, is very unusual for even the larger companies. The Rockford & Interurban Railway management believed, however, that the small investment in a line department building and storage yard would be worth while in that the building could be used not only as a workshop and storeroom but a portion could be set aside for housing the tower wagon, automobile and teams.

As shown in the illustrations, the layout consists of a two-story plainly constructed brick building, 24 ft. x 52 ft. in plan. The lower floor is divided into three sections, one of which is used for a lineman's workroom, another for housing the tower wagon and automobile and the third section for the horse barn. The upper floor is divided into two rooms, one a storeroom for overhead material and the other used for storing feed for the teams.

At the rear of the building a storeyard has been fenced off with a high board fence and sheds have been provided for housing the emergecy tower wagon and dump wagons used by the track departmet. The yard area is also used for storing material which the weather does not affect materially, such as poles, cross arms and surplus reels. A wide concreted driveway has been constructed from the street to the storage yard entrance so that heavy loads can be handled to and from the property easily.



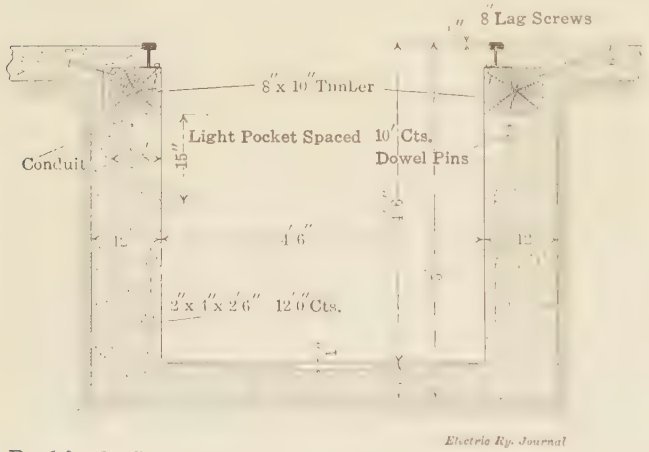
Rockford Carhouse and Shops—Sections Through Two-Story End and Repair Shop and Track Bays

OVERHEAD LINE DEPARTMENT ORGANIZATION.

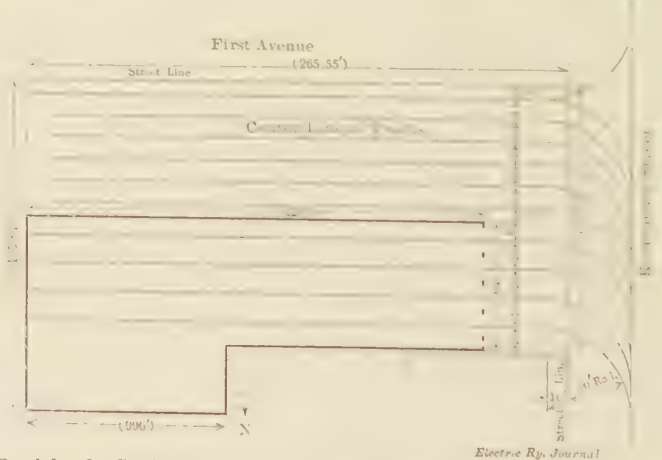
The overhead department is under the supervision of the electrical engineer for the company. Owing to Rockford's location, which is central relative to the properties owned by the company, the territory covered by the department includes the interurban lines and the city railway properties at Rockford, Beloit and Janesville. The work of the department includes all overhead line maintenance and construction, track bonding, substation and all building lighting maintenance. The department organization includes the electrical engineer at its head and a bonding foreman, line foreman and gang foreman who report to him. At the present time there is very little construction work on hand, and twelve men are able to handle the work properly. The department equipment includes a bonding car, a tower wagon for city work, a line car for interurban work, an emergency tower wagon and automobile and two light wagons that are used for hunting emergency trouble along the transmission lines that do not follow either the tracks of the interurban or city lines.

One of the great advantages of the overhead department building is that the linemen can be kept at work in the workshop in bad weather. As a result a large amount of repair work is turned over to them, such as lightning arresters to be adjusted and tested, telephones to be rebuilt, the manufacture of jack boxes and second-hand line material to be reclaimed for use on repair work.

The workroom has been supplied with individual lockers for the linemen's tools and a 500-volt testing outfit for testing lightning arresters and second-hand insulators. The storeroom on the second floor of the building is under the charge of one of the foremen and the electrical engineer. All material is issued on a written requisition, which is used as a record of the material given out. The stock consists of all the surplus line material on hand, both new and second-hand. The department was organized by G. G. Crane, electrical engineer of the Rockford & Interurban Railway, under the supervision of W. C. Sparks, general manager.



Rockford Carhouse and Shops—Cross-Section of Pit Showing Light Pockets



Rockford Carhouse and Shops—Plat Showing Lot and Location of Carhouse

Car and Track Maintenance in Richmond and Norfolk, Va.

Among the More Important Work of the Past Year Were the Conversion of Single-Truck Cars to Double-Truck Cars and the Extensive Introduction of Steel-Tie Track Construction

Upon the termination of its receivership on July 1, 1909, the Virginia Railway & Power Company, Richmond, Va., embarked upon an extensive plan of betterments, which included a thorough rehabilitation of way and rolling stock and the construction of new carhouses, shops, generating plants, substations, high-tension transmission line and an office building. The first work undertaken was the erection of new shops and carhouses in Richmond and the building of an operating terminal in Manchester, both of which were described in the ELECTRIC RAILWAY JOURNAL for April 2, 1910. In addition to this work the company is also completing plans for carhouses and shops at Norfolk for the Norfolk & Portsmouth Traction Company, which was acquired on July 1, 1911. The present article will describe the improvements made in general car maintenance, shop practice and track work. The enlargement of power facilities and the new office building will be considered in two other articles. All of the work in Richmond and Norfolk is being carried out under C. B. Buchanan, general manager. The growth of the Richmond system during the last four calendar years, as indicated by statistics of passengers carried, car miles and car hours operated, is shown in the following table:

Year.	1908.	1909.	1910.	1911.
Passengers carried	39,369,646	43,011,654	47,682,978	50,069,369
Car miles	6,732,306	6,758,896	6,906,389	7,116,611
Car hours	818,536	825,957	844,907	868,678

IMPROVED RELIABILITY OF CAR SERVICE

The enlargement and general improvement of the shops as hereinafter described has had a most beneficial effect on the reliability of the car service. Thus, in December, 1911, 3662 miles were operated per car failure as compared with 2529 miles for the same month of 1910. This meant that there were only 161 car failures in the latter year for 589,679 car miles as compared with 227 car failures in 1910 for 574,274 car miles. The average mileage per car was also higher. The comparative figures for August, 1911, and August, 1910, show that the service during the summer months has also been improved. It appears, for instance, that in August, 1911, there was but one failure per 4079 miles as compared with 2855 miles in August, 1910. This corresponded to 152 car failures for 620,008 miles and 212 failures for 605,366 miles respectively.

The ELECTRIC RAILWAY JOURNAL for Nov. 12, 1910, and Jan. 14, 1911, described the principal shop records which were then in use by this company. Two additional forms have been adopted, one to cover accidents to individual cars and the other to give the details of controller accidents. Typical reports as made on these forms are reproduced on this page. The purpose of the report on accidents to car equipment is to segregate those charges which are due to accidents from those which are due to legitimate maintenance. This record gives a complete shop time, labor and material statement, in addition to presenting the time of the accident and the names of the crew. The controller accident blank was devised to record similar data. For legal reasons, it was found very desirable to have a special controller record because a large percentage of damage suits are based upon what the complainants term "controller explosions." This report shows the cause and nature of the trouble as determined by the shop expert, a detail of the actual damage, the cost of repairs, the date the car was last inspected before the accident, by whom it was examined after the accident and other pertinent information.

ENLARGED SHOPS

A plan of the reconstructed and enlarged shops was published on page 601 of the ELECTRIC RAILWAY JOURNAL for April 2, 1910. This plan showed that the old paint shop was to be used for a machine shop and that the old machine shop was to be used for a carpenter shop and mill room. The new paint shop combines the advantages of fireproof construction with ample skylight area. It is a six-track structure, 80 ft. x 90 ft. in area, with entrances via a transfer table. It is constructed of brick for the walls and concrete for the roof and columns; wired glass is used for the numerous small skylights and for the metal-frame windows. One practice which helps to reduce the fire risk of the paint shop is that of mixing all paints in a steam-heated room which forms one of the two sections of the oil house. This oil house and its partition are of brick. The contents of the oil room are stored above ground, except the gasoline tanks, which are placed 5 ft. underground outside the building line. Hand pumps are provided in the oil room for drawing this gasoline as required.

VIRGINIA RAILWAY & POWER COMPANY.

ACCIDENTS TO CONTROLLERS.

Report No. 5817

Richmond Division. Date, *Jan.* 9, 1912

Car No. 32. Time, 5.30 P. M. Date of Accident, *Jan.* 8, 1912.

Motorman, *J. W. Thomas.*

Conductor, *G. W. Henderson.*

No. 1 or No. 2 End, *No. 2 end controller burnt.*

Date Car Last Inspected, *Dec.* 30, 1911.

Inspector's Name, *T. F Latta.*

Circuit Breaker, *O.K.*

Car Examined by *E. E. Goodrich* ..... After Accident.

Cause of Trouble, *Grounded field, No.* 1 *machine.*

Damage to Equipment, *Grounded field. Controller burnt on operating cylinder between first and section sections; also trolley finger burnt off.*

Total Cost of Repairs, $16.02.

Remarks .....

W. J. Hicks, Foreman.

Richmond Maintenance—Report on Controller Accidents

VIRGINIA RAILWAY & POWER COMPANY.

ACCIDENTS TO EQUIPMENT.

Report No. 5996.

Richmond Division. Date, *Jan.* 31, 1912.

Car No. 142. Time, 5.32 P. M. Date of Accident, *Jan.* 31, 1912.

Motorman, *Lemmerick C. G.*

Conductor, *Hadcock P. W.*

Damage to Car 142. *In accident breaking one fender, one basket, two swords and one headlight glass.*

Date in Shop, *Jan.* 31, 1912. Date Out of Shop, *Jan.* 31, 1912.

Labor,	1½ *hours @ 20 cents*	$0.30	
	5 *hours @ 15 cents*	0.75	
			$1.05
Material Used,	2 *fender swords*	$0.60	
	1 *headlight glass*	0.10	
	2 *pieces* 1 15/16-*in. x* 2⅛-*in. x* 6-*ft.* 2-*in. hickory*	1.00	
	24 5/16-*in. x* 2½-*in. carriage bolts*	0.11	
	72 ¼-*in. x* ½-*in. round-head stove bolts*	0.13	
			$1.94
	Total Cost		$2.99

Remarks .....

Richmond Maintenance—Report on Miscellaneous Accidents

One practice which helps to reduce the fire risk of the paint shop is that of mixing all paints in a steam-heated room which forms one of the two sections of the oil house. This oil house and its partition are of brick. The contents of the oil room are stored above ground, except the gasoline tanks, which are placed 5 ft. underground outside the building line. Hand pumps are provided in the oil room for drawing this gasoline as required.

The present woodworking shop, which occupies the place of the former machine shop, has had its equipment enlarged by the addition of a shaper, tenoning machine and mortiser. An electric car hoist has been provided in the overhauling department. Advantage was taken of the change in location to furnish most of the tools with direct drive and to place all wiring in conduit right up to the mo-

tors. The use of variable speed motors instead of cone pulleys and beltings has proved especially satisfactory.

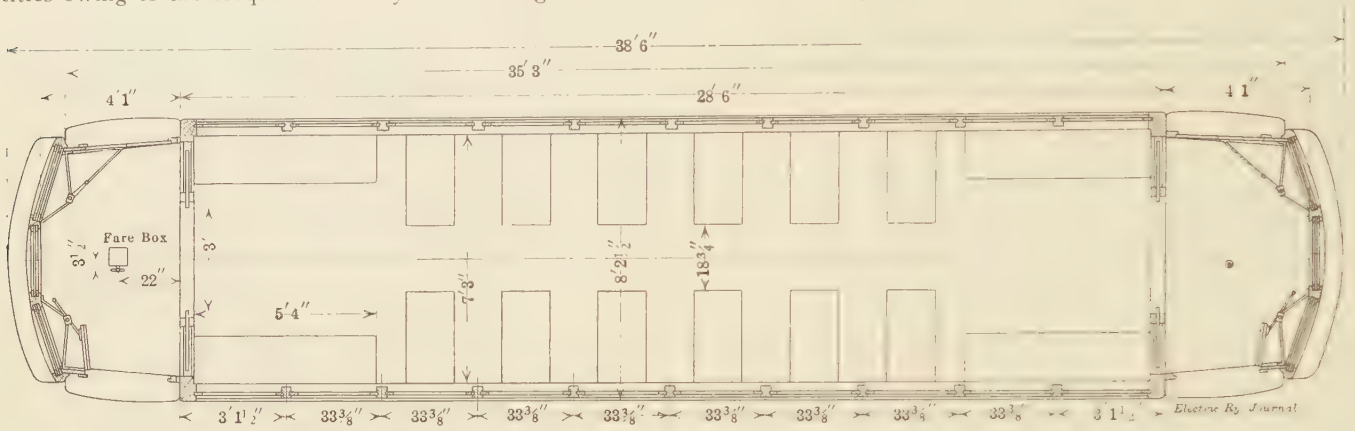
The new brick blacksmith shop did not require additional forges, but a 250-lb. air-operated hammer was installed. An auxiliary to the woodworking shop is a corrugated-metal building in which car lumber for five years' seasoning is stored. Each piece of wood is marked with the earliest date when it will be available for use. The principal lumber stored is mountain oak, which is purchased in large quantities owing to the frequent difficulty in obtaining seasoned oak suitable for cars. Little ash is stored here, as it rots quickly in the Richmond climate and seasoned ash is easy to obtain.

The care used in handling scrap at these shops appears from the fact that the yard has been furnished with a 30-ft. standard track scale upon which all scrap is weighed and placed in separate storage bins before it is credited to the proper account.

The arrangement of the Richmond shops in a number of different buildings made it particularly desirable to have quick communication between all parts. Last February, therefore, a private telephone system with nine telephones and booths was installed for the use of the foremen and others engaged in company business. One of the most valuable features of the telephone service is that it has eliminated waste of time in getting supplies. Formerly nearly every man seemed to find it necessary to pay a visit every morning to the storeroom, where he would often spend an hour or so before securing and leaving with his supplies. Now the foreman of each department telephones for supplies, which are delivered by storeroom messengers.

CAR REBUILDING

During 1910 the company introduced double-truck, pay-as-you-enter cars which met with such approval from the public that the company was led to look into the practicability of lengthening the single-truck cars and of rebuilding their platforms for prepayment service. It was found that the 20-ft. single-truck car bodies could be converted to 28-ft. 6-in. double-truck prepayment cars with air brakes for about $750 per car. Twenty of these cars are now being so rebuilt. The change has proved so satisfactory that a number of cars on the Norfolk line will be rebuilt in the same manner.



Richmond Maintenance—Plan of Double-Truck Car After Reconstruction from Single-Truck Design

Richmond Maintenance—Lengthening a Single-Truck Car for Double-Truck Operation

The accompanying halftone engravings show one of the single-truck cars before being converted, its appearance as a double-truck car during construction and the completed double-truck car. The accompanying drawing shows the floor plan and the seating arrangement of the double-truck car.

The single-truck cars had seven windows on each side.

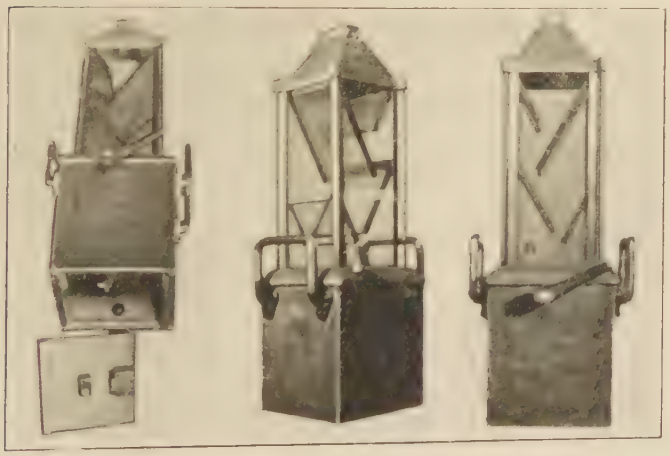
To enlarge the car, the side sills and frames were cut at the center and new pieces, 8 ft. 4 in. long, were inserted to obtain a car with ten windows. The single-truck car had a ½-in. x 7-in. steel plate on the outside of the side sill. This plate was removed and a 6-in., 8-lb. channel bolted to the side sill the entire length of the body. This channel, which is used on all Richmond cars, projects about 2 in. beyond the

Richmond Maintenance—Original Single-Truck Car

side and therefore saves the body from much wheel scraping besides stiffening the framing. To prevent sagging at the ends and center, each car was provided with a 2-in. x ½-in. truss rod, supported by queen posts at the bolsters, and with a body truss rod extending from the bolsters from two queen posts near each side of the center. It has been found that this truss construction, combined with the 6-in. channels which are bolted to the side sills, amply counteracts any weakness that may be due to the splicing of the side sills.

A few dimensions of the finished car may be of interest. It is 38 ft. 6 in. over the bumpers, 28 ft. 6 in. over the corner posts, has 4-ft. 1-in. platforms and an extreme width of 8 ft. 2½ in. over the window posts. The seating arrangement comprises twelve 32-in. cross seats and four 5-ft. 4-in. longitudinal seats, giving a seating capacity of forty. The platforms were furnished with two 15-in. folding doors on each side. These doors are operated by the motorman through a lever which is installed at one side of the controller at about 5 ft. above the floor. The car body is mounted on double trucks, one of which is equipped with two 50-hp motors. The car when equipped and ready for service weighs 34,000 lb., or 850 lb. per passenger.

The fare box is placed near the center of the platform, where it is supported by a movable bracket in a floor socket.



Richmond Maintenance—Home-Made Cash Box

This arrangement enables the fare-box bracket to be moved from one end of the car to the other. The conductor's position is just behind the fare box, facing forward.

In addition to the foregoing reconstruction, the company is changing over ten single-truck cars to prepayment operation. The principal change in this case is the installation of two 15-in. folding doors on each platform with the same door mechanism as used on the lengthened cars. The platform width of 4 ft. 1 in. has not been altered, nor has any change been made in the body doors, which are of the double sliding type. The cost of this change is about $125 per car.

MISCELLANEOUS SHOP PRACTICES

Since September, 1910, the Richmond company has operated forty two-motor equipments of the commutating-pole type. High-grade brushes are used, and as yet the motors have shown no perceptible commutator wear. The motors are mounted on maximum traction trucks which carry vestibuled cars 43 ft. 6 in. long over all. When the equipment of these cars was under consideration it was thought at first that four 50-hp motors would be required per car to operate on the Richmond narrow-groove rail and the maximum grade of 13 per cent. The experiments then made with a trial car equipped with maximum traction trucks and two 65-hp motors foreshadowed the present success of this combination in every-day service.

A trial of 100 one-wear steel wheels is now under way. These wheels, which are chiefly for city use, are of 33-in. diameter, but the city wheels have a ⅝-in. flange, whereas the interurban wheels have a ⅞-in flange. Upon being weighed in the yards at Richmond, it was found that the one-wear city wheel weighed 416 lb. and the one-wear interurban wheel 426 lb. The weight of a 33-in. diameter cast-iron wheel proved to be 420 lb. These weights of one-wear steel wheels compare very favorably with solid steel wheels, as the latter weigh from 550 lb. to 650 lb. The Richmond management has not bought these one-wear steel wheels for mileage reasons but primarily to eliminate flat wheels.

Richmond Maintenance—Former Single-Truck Car

The five cars of the Richmond-Petersburg interurban line have been equipped with coasting recorders since December, 1911. The first month showed that the installation of these meters produced an apparent saving of 15 per cent in energy compared with the preceding month.

On account of their excessive breakage, ground-glass destination signs are being replaced by a perforated sheet steel sign of No. 16 gage. The body of the sign is black and the lettering is white. The letters are bounded by 3/16-in. holes, which are punched at ¼-in. centers to admit light from the lamp placed behind the sign. In making a new sign, the perforations of the first are carefully measured so that the sample can serve as a jig, to secure absolute uniformity.

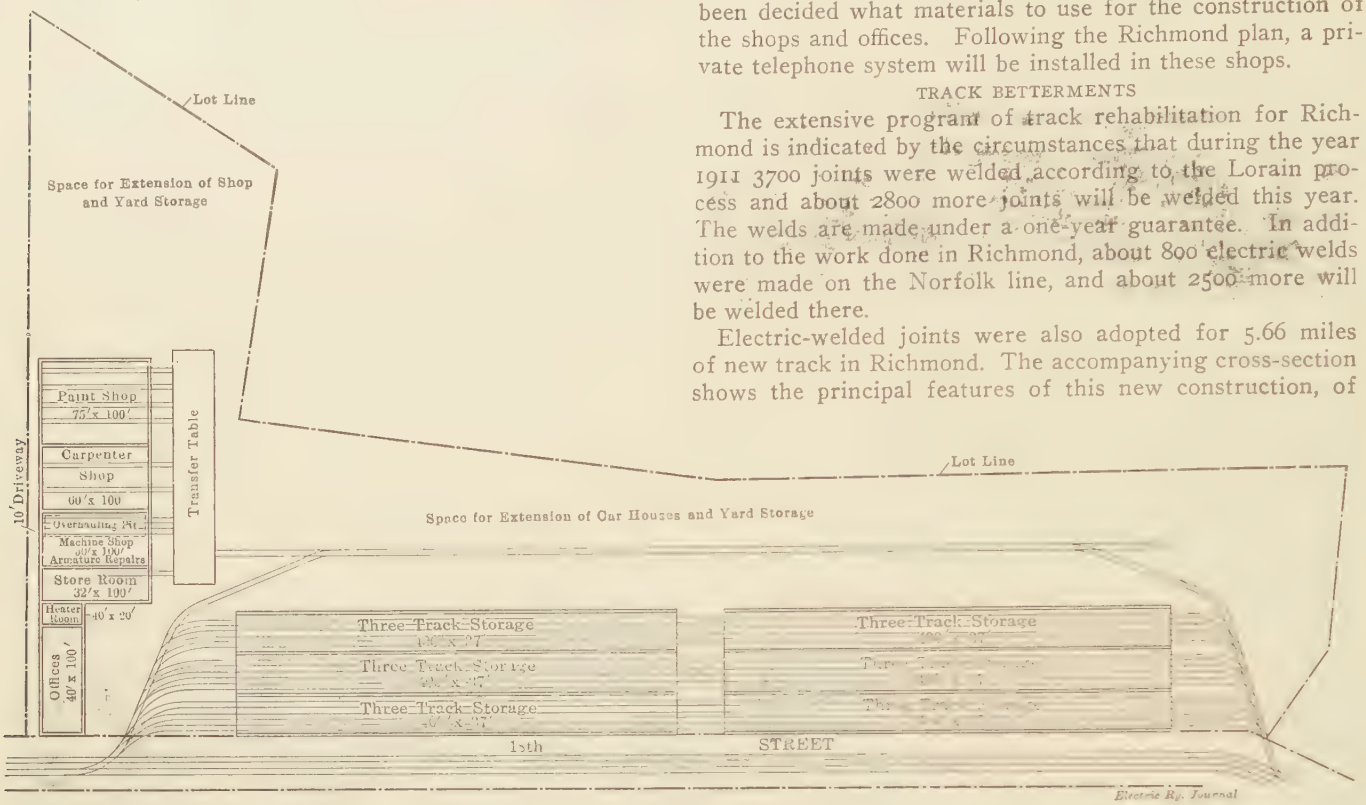
CASH BOX

The prepayment cars are supplied with home-made, non-registering fare boxes, of which about 150 are now in use in Richmond and Norfolk. Following the usual practice, every conductor has his own fare box. The standard types of register are installed in the cars, and each fare deposited in the fare box is registered by the conductor. The box has an aluminum top piece, a glass frame with brass corner strips and an aluminum cash receptacle, which is fitted with a Yale lock and a sealed keyhole. The lowest incline of the coin chute is hinged so that it will swing over and close the mouth of the chute in case the box is turned upside down to shake out any money left on the coin table. In addition to this feature, a unique telltale has been provided to betray tampering. This telltale consists merely of a split plug

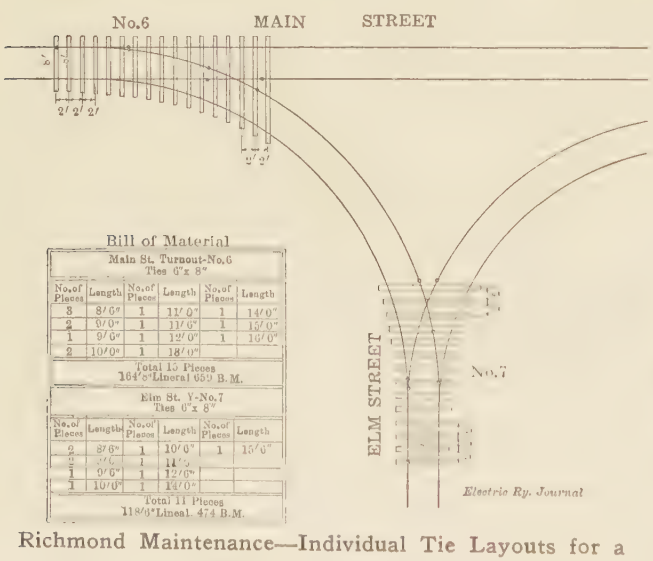
which is set on an inside bracket near the bottom of the glass frame. Should the box be overturned, the plug drops out of the bracket and cannot be replaced no matter how much it may be juggled about. A preliminary trial showed that if a ball were used for this purpose it would be possible to return it to the bracket. This box weighs only 20 lb.

NEW SHOPS AND CARHOUSES IN NORFOLK

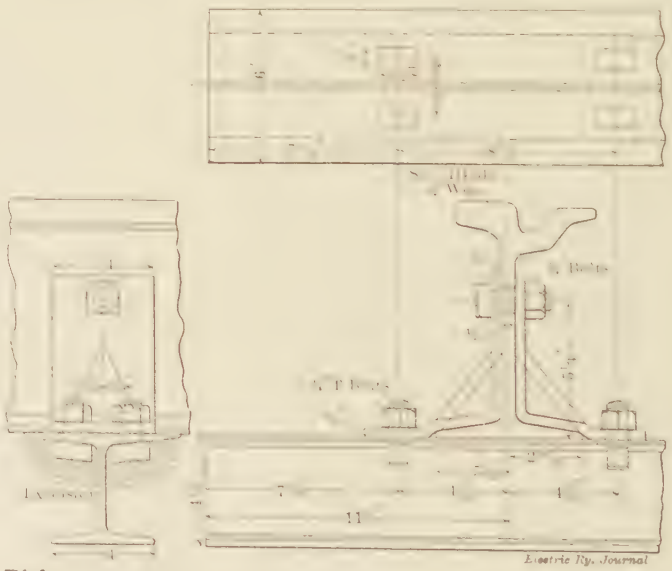
The company is now completing plans for the construction of two storage carhouses and general shops on Eighteenth Street, Norfolk, which is about the geographical center of that city. This installation will greatly improve the present housing facilities in Norfolk and also make it unnecessary to rely upon the Richmond shops for manufactured parts. As shown in the accompanying plan, the cars will be stored in two buildings, each consisting of three 400-ft. x 37-ft. bays. Room for a duplicate installation is provided alongside. It has been decided to use concrete foundations, hard-burnt brick walls and reinforced-concrete roofs for the carhouses. The center of each carhouse bay will have a continuous wire-glass skylight. Two track entrances will be used, one at the rear end for 4-ft. 8½-in. gage, and one at the front for 5-ft. 2-in. gage. It has not yet been decided what materials to use for the construction of the shops and offices. Following the Richmond plan, a private telephone system will be installed in these shops.



Richmond Maintenance—Plan of New Carhouses and Shops at Norfolk, Va.



Richmond Maintenance—Individual Tie Layouts for a Special Work Installation



Richmond Maintenance—Detail of Steel Tie Fastening Using Beveled Head Bolts in Rectangular Holes

TRACK BETTERMENTS

The extensive program of track rehabilitation for Richmond is indicated by the circumstances that during the year 1911 3700 joints were welded according to the Lorain process and about 2800 more joints will be welded this year. The welds are made under a one-year guarantee. In addition to the work done in Richmond, about 800 electric welds were made on the Norfolk line, and about 2500 more will be welded there.

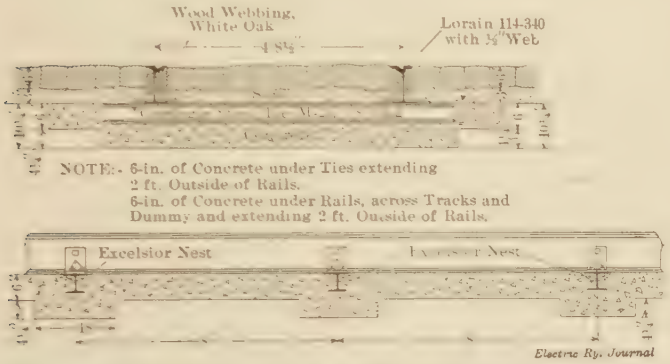
Electric-welded joints were also adopted for 5.66 miles of new track in Richmond. The accompanying cross-section shows the principal features of this new construction, of which 1 mile is already in place. In accordance with the requirements of the city engineer, the foundation is of concrete laid to a depth of 6 in. below the ties. This sub-base is carried out to a distance of 2 ft. on each side of the rails to embrace the paving strip which must be maintained by the railway. The standard tie is the Carnegie M-25, which is 6 ft. 8 in. long. This steel tie is laid 8 ft. centers ordinarily, but a spacing of 6 ft. is used in heavy traffic sections. This wide spacing was made possible, of course, by the excellent substructure.

In the usual form of Carnegie tie fastenings the bolt passes through a round hole in the tie, thereby making it necessary to chisel under the bolt head whenever renewals

are desired. In the Richmond construction the future removal of the bolts is simplified by using a rectangular slot in the tie and applying a bolt with a special head which is beveled to the same angle as the underside of the tie flange. After this bolt is installed a nest of excelsior is made around the head so that concrete can be rammed all around it without possibility of contact. After the concrete is set braces and bolts can be removed, when necessary, without disturbing the concrete.

Wood webbing is used alongside the rails instead of concrete or other filling. Wood webbing does not disintegrate and so avoids the displacement of adjacent paving. The wood webbing can also be readily removed and replaced.

Part of the new 114-lb. rail, steel-tie construction is replacing a section of 98-lb. rail, wood-tie construction on Main Street, which was laid in 1896. Most of the ties were of white oak and the remainer of red oak, both untreated. The ties in the poorly drained parts were found worthless, but the others, although in use for some sixteen years, were still serviceable enough for suburban lines. It is possible that creosoted ties will be used in the future if their cost compares favorably with steel ties. As early as 1902 the


Wood Webbing, White Oak
Lorain 114-340 with ½" Web
4 8½
NOTE:- 6-in. of Concrete under Ties extending 2 ft. Outside of Rails.
6-in. of Concrete under Rails, across Tracks and Dummy and extending 2 ft. Outside of Rails.
Excelsior Nest
Excelsior Nest
Electric Ry. Journal

Richmond Maintenance—Cross-Section and Longitudinal Section of New City Track

Richmond company laid 95-lb. rails on steel ties on Eighth Street. These ties, which were placed 10 ft. centers, are still in service, but it is necessary to use shims in some places to maintain the alignment.

The cross-section previously mentioned shows that the present rail for tangents is the Lorain section 114-340. The same company's section 119-341 is used on curves. Girder rail special work is ordered in accordance with the following specifications, which present fully the company's practices in regard to standard radii for switches and mates, etc.:

STANDARD SPECIFICATIONS FOR GIRDER RAIL SPECIAL WORK

Rail.—All new work to be furnished in 9-in. guard rail of standard open-hearth steel as may be specified; also solid manganese rails to be furnished when called for.

Tongue switches and mates shall be of standard 100-ft. center radius for laterals and standard 200-ft. center radius for equilaterals, and the body of switch and mate to be cast steel, unless solid manganese be specified. Tongue switches are to be of the pinless type, 13 ft. 6 in. long on the straight and 12 ft. long on the curve. The mates are to be 12 ft. long on the straight and 13 ft. 6 in. on the curve. All arms of castings on all switches and mates must be finished to exact size of guard rail specified, so that standard plain rolled channel splice bars may be used to connect with the abutting rolled rail. All cast-steel switches shall have a manganese bed not less than 8 ft. 6 in. long, and the same shall be securely fastened to cast-steel body of switch. Tongue to be of solid manganese of the reinforced type, to be not less than 7 ft. long. All switches are to be cored for attaching spring box, and tongues are to be furnished with lugs. The guard side of switches in arms at both toe and heel is to be ⅜ in. above head of rail. All cast-steel mates shall have a manganese bed not less than 4 ft. long, and same shall be securely fastened to cast-steel body of mate.

Frogs and crossings to be of cast steel with manganese wearing plates of such type that same may be successfully renewed without removing the surrounding pavement. Frogs and crossings are also to be furnished of solid manganese where called for.

Switches, mates, frogs and crossings to be of exact lengths specified and to be level throughout their entire lengths and true to alignment and angle. Frogs to be of A. E. R. A. standard length where possible.

Renewable manganese centers to have flange bearings ⅝ in. deep exactly, and have risers as long as length of center will permit; the latter to drop toward the ends of the plate and to be made to match rail where the plate joins the rail. In solid manganese work, flange bearings are to be ⅝ in. deep exactly and have the proper gradual dip not more than 1/16 in. in 1 in. until it reaches the full depth of the groove in the rail.

Tread Clearance.—All special work to have sufficient clearance to provide for the operation of wheels with 4-in. tread.

Ends of rail at joints to be cut square or radial with gage line.

Joints.—The abutting rails must be true to alignment and surface when plates are bolted up.

Joint plates are to be furnished at all joints and connections with existing work. They are to be of the standard and of the company's standard length and punching. They must be curved to the curvature of the rail and must fit tightly under the head, guard and base rail and stand away from the web of the rail when all bolts are tightly drawn. Joint plates and other corresponding joints must be plainly marked or stamped with the same signs as the working drawings.

Arms.—When arms of switches, mates, frogs and crossings of new work connect up with existing track of a different rail section from the one used in the new work, such arms must conform to a grooved rail section that would take the company's standard joint plate, unless specially ordered otherwise.

Standard drillings for joints in 9-in. work shall be twelve hole; hole to be 1¼-in. diameter, located 2½ in. x 5 in. x 5 in. in upper row of bolt holes, and 3½ in. x 5 in. x 5 in. in lower row of bolt holes. Bolt holes to be located to manufacturers' standard vertical spacing.

Joints shall be of the standard rolled ribbed type, 32 in. long, and to have twelve 1-in. diameter bolts, U. S. standard thread, with elliptical shanks and square nuts.

Electrical Drilling.—All cast-steel and roll rail pieces are to be shipped with no electrical drilling. Solid manganese special work and rail to be drilled with two ⅞ in. diameter holes in each end of rail, one each located half way between first and second holes in the upper and lower row of bolt holes.

Drawings.—Manufacturers must furnish the company with two detail drawings showing the type of switches and mates they intend furnishing, which must be approved by the company before proceeding with the work.

Working Drawings.—Two copies of working drawings shall be sent to the company not later than the date work is shipped; drawings to have dimensions of all pieces, over-all distances, tangents, chords, externals, etc., given.

Checking.—Before shipping, all the work must be laid out on a level surface with all plates bolted up, tie rods put in when called for, and entire work checked for curvatures, gage, partial and over-all distances, which dimensions must truly correspond with those on the working plans accompanying work.

Markings.—All pieces must be plainly and distinctly marked or stamped according to signs on the working drawings, so that the work may be easily assembled in the street.

Inspection.—The company reserves the right to send its own inspector to inspect the work during the process of construction or before it is shipped. In such a case the manufacturer must give the inspector all facilities and assistance he may require to enable him to inspect the work as to construction in detail and measurements.

Changes in Specifications and Drawings.—No changes that may be made in work varying from the description on drawings will be accepted unless the manufacturer has written instructions to that effect.

An excellent feature in connection with the special-work layouts is that calculations are made in each case for the best arrangement of ties so that the special work will have a firm and uniform bearing, instead of crowding the ties at one place and scattering them at another. Hence whenever a new piece of special work is to be laid or an old piece is to be renewed a drawing is made to show the desired location and size of every tie. Good bearing for the special work lengthens its life and permits smoother car operation. A typical layout and bill of material for the same are presented in a drawing on the preceding page. In renewing special work originally installed on dirt foundations in unpaved streets, the company uses for a new tie foundation the disintegrated concrete taken up from the paved streets where track has been reconstructed.

ANNUAL REPORT OF BERLIN STREET RAILWAY

The Grosse Berliner Strassenbahn's annual report for the calendar year 1911 shows that the company paid a dividend of 8¾ per cent on its stock capital of approximately $25,000,000. The gross earnings from passenger traffic were $10,871,000 compared with $10,365,750 in 1910, and the respective operating expenses were $5,978,000 and $5,761,250. The operating expenses were 55 per cent of the gross earnings compared with 55.6 per cent in 1910. The number of passengers carried increased from 427,700,000 to 447,000,000, and the car mileage from 60,281,159 car miles to 62,919,501 car miles. The gross earnings per car mile were 16.8 cents as in 1910. The expenses included $238,603 for the welfare of 11,453 employees, $227,609 for maintenance of track and overhead lines, $217,848 for accidents, $778,942 for rolling stock maintenance and improvements and $1,272,700 for electrical energy. The total mileage is now 338 miles, an increase of 6.6 miles compared with 1910. The number of cars was increased from 2628 to 2737. After the payment of the stock dividend, $125,000 was set aside for the amortization fund covering right-of-way, $625,000 for fund I, covering renewal of right-of-way only as power is purchased, and $137,500 for renewal fund II, covering rolling stock. The municipalities in which the company operates received $741,977.

Rolling Stock Maintenance at Worcester, Mass.

Equipment and Operating Methods of the Mechanical Department of the Worcester Consolidated Street Railway, —Efficient Service Rendered by Comparatively Old Shops in the Heart of the City

One of the largest interior street railway systems in New England is that formed by the properties of the central Massachusetts district which are brought to foci in the cities of Springfield and Worcester. Under the management of the New England Investment & Security Company about 500 miles of track are operated in an organization which embodies the benefits of uniform methods of administration and furnishes the public with a thoroughly co-ordinated service to meet the demands of a rapidly increasing passenger and freight traffic. Within the past two years special attention has been given to the standardization of cars and car maintenance.

SCOPE OF ORGANIZATION—ROLLING STOCK

The mechanical department of the Worcester Consolidated Street Railway Company now has the largest facilities for rolling stock maintenance available on any of the lines of the greater system. All of the heavier classes of repair work are therefore centralized at Worcester. The lines of the Worcester system comprise about 250 miles of track and include, besides the urban network, many radial suburban and interurban routes serving the Blackstone Valley and the Marlboro, Fitchburg and Southbridge districts. About 650 cars are maintained in the Worcester routine service, and the mechanical department also handles much repair and reconstruction work for the allied lines. On the Worcester system proper are 561 closed and open passenger cars, including 47 single-truck and 207 double-truck closed cars, 141 single-truck and 166 double-truck open cars, besides 9 double-truck express cars, 7 line cars, 18 work cars, 1 parlor car, 6 sand cars, 41 snow plows, 3 sweepers, 1 wrecker, 1 advertising car and 2 electric locomotives. The open passenger cars range in size from eight-bench units with 18½-ft. bodies to fifteen-bench equipments with 34-ft. 4-in. bodies, and the closed cars vary from units having 20-ft. bodies to double-truck cars having 34-ft. bodies, the former seating thirty passengers and the latter forty-eight each. Sixteen types of railway motors are used by the Worcester company.

The standard closed car for city service is a double-truck equipment about 41 ft. over all, with a 28-ft. body, seating capacity of thirty-six passengers, maximum width of 8 ft. 7 in., painted Pullman color, and having two 60-hp motors, longitudinal seats and mahogany interior finish. The standard open car is a twelve-bench unit, with a length of 34 ft. 2 in. over end sill, total width of 8 ft. 4⅜ in., double trucks, two 40-hp motors, ash exterior finished in natural color and mahogany interior finish. Air brakes are used on all double-truck cars.

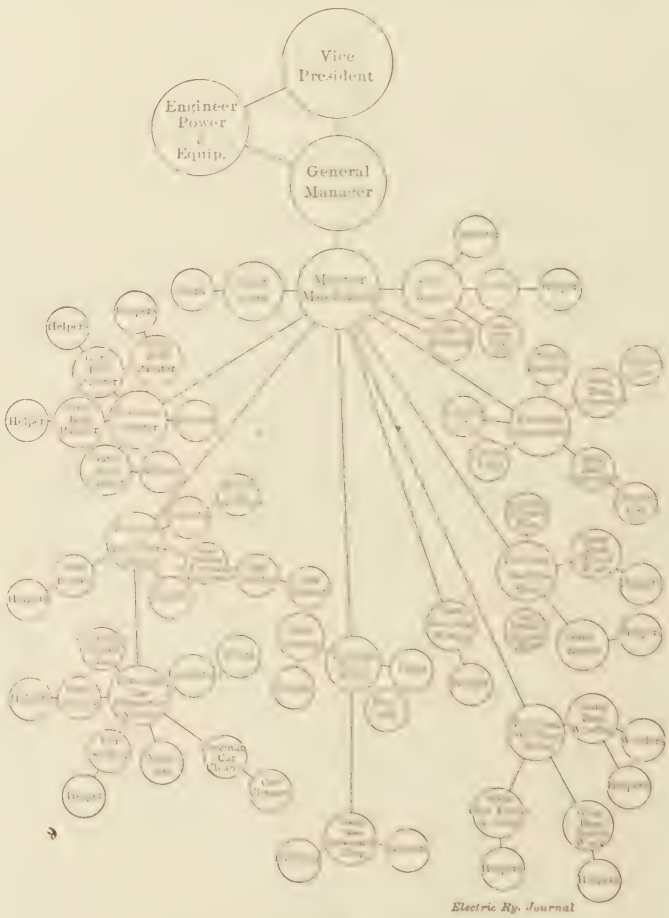
SHOP AND CARHOUSE ORGANIZATION

The headquarters of the rolling stock maintenance department at Worcester are the Market Street shops, which are located about ½ mile north of the business center, with a Main Street frontage. Any car brought into the center of Worcester can reach the shops inside of three minutes. Seven other operating carhouses are in service in the Worcester district, these being at Gates Lane in Worcester, Charlton City, Oxford, Leominster, Northboro, Uxbridge and Unionville. The organization of the mechanical department for the Market Street shops is shown in the accompanying diagram. Each subordinate carhouse also has an organization as typified by the accompanying diagram on page 573 to cover Gates Lane.

The general manager of the Worcester system has general jurisdiction over the mechanical department, subject to the executive supervision of the vice-president of the New England Security & Investment Company at Springfield. At Springfield an engineering department headed by an engineer of power and equipment acts in an advisory capacity to both the vice-president and the general manager, the engineer having broad powers of direction respecting car maintenance. The immediate maintenance work is in charge of a master mechanic, whose headquarters are at Worcester, the various shop departments and outside carhouse inspection and repair work being under his jurisdiction.

MARKET STREET SHOPS

The Market Street shops were built in 1894, additions having been made in 1902 and 1907. The plant is of particular interest on account of the improvements which have lately been made to insure economical repair service, and it illustrates in a marked degree how much wise management



Worcester Shops—Organization Diagram Covering the Carhouse and Main Shops

can do with limited means. The building is a brick, steel and wooden structure with a ground floor for car storage, pit room, overhauling, blacksmith and machine shop and storeroom. The upper floors of the front are set apart for various offices, with a school for trainmen, pattern shop and wood mill, setting-up shop, painting, upholstery and electrical repair sections located behind the offices. The car storage division has a capacity of 125 cars with 30-ft. bodies, and the building has a frontage of 73 ft. on Main Street and a length of 447.5 ft. on the Market Street side. Two wings, with an over-all width of 113 ft. and an average length of about 265 ft., flank the Main Street front at the rear of a small group of buildings used for other purposes. The shop group therefore occupies the larger part of the block between Market and School Streets, facilities for

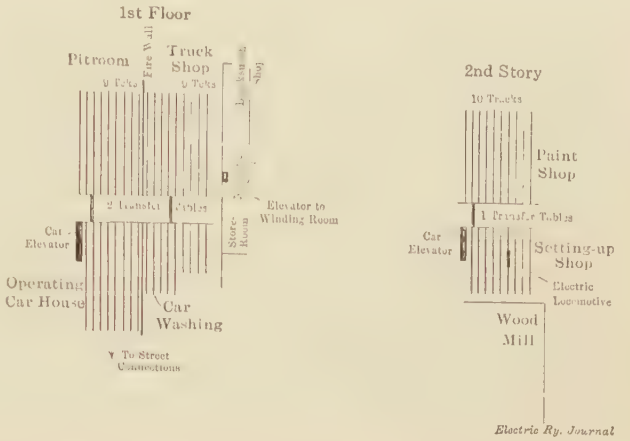
the receipt of supplies by team being available on the latter or south side of the building. Two entrance tracks connect the shop and carhouse building on the Main Street front with the two main line tracks passing the property, and the former branch into nine parallel tracks inside the building, the operating carhouse being immediately within the doorway.

At the rear of the operating division, which is about 200 ft. deep, an electrically driven transfer table serves all the storage tracks and handles all cars for the pit room, which has nine tracks, each with a pit for the full length. A second transfer table also occupies the runway between the broken track sections and is utilized mainly in handling cars between the south side of the house and the north side. The south side contains nine additional parallel tracks in the overhauling shop and is continued from the storage section west of the latter beyond the transfer table runway into a washroom and secondary storage area. The machine shop parallels the southerly storage area and overhauling shop, the blacksmith shop being located at the extreme east end of the building behind the machine shop and next to the overhauling division. The arrangement described is a substantial improvement over the former situation, since cars can be handled between the street and any of the inspection or heavier repair divisions at high speed, while the use of two transfer tables insures rapid movement of cars between the departments. The location of the pit room behind the operating or regular daily storage section aids early inspection, and the situation of the machine shop, main storeroom and blacksmith shop in proximity to the overhauling shop greatly hastens the handling of heavy parts and the making of truck and brake-rigging repairs and of wheel or bearing changes.

A highly efficient method of handling car bodies has also

Worcester Shops—Carhouse and Main Shops

been developed. Practically all of this work is handled on the second floor, to which the bodies are delivered by a 40-ton, 46-ft. x 10-ft. hydraulic plunger elevator. The second floor is about 20 ft. above the first floor, and when a car is received on the first floor it is carried by a transfer table to any of ten tracks in the setting-up shop and paint shop, the two being separated by the transfer runway. To facilitate the handling of dead cars a small electrically operated shifter is in service. It is built of a single truck carrying an 11-ft. x 6-ft. platform, 3 ft. above the floor, and equipped with a Westinghouse No. 3 railway motor, hand brake and rheostatic control. By means of it and the transfer table a car can be placed in the most distant corner of the second story inside of five minutes from its arrival at



Worcester Shops—General Plan of Market Street Shops

the shop entrance. All tracks have overhead trolley connections to enable cars to be moved under their own power to the maximum extent possible. The various departments are also well equipped with overhead hoists and telpher runways, and an electric elevator with a platform 60 in. square is in service between the armature room, machine shop and basement below the latter, where heavy truck supplies are stored. The elevator has a doorway opening into the car storage house outside the main storeroom, to facilitate rapid handling of material between the different floors.

PIT ROOM

The pit room has a 15-ton hydraulic jack of 6-ft. travel and a wheel grinder for pit service. Inspection work and wheel and armature changes are handled here. Eight Barrett jacks are used for armature removals, these jacks being mounted on small hand trucks for pit service. The rails are sectionalized for wheel changing.

The regular work includes the inspection of about seven cars daily and a night inspection of all cars housed in the department. The night examination mainly covers the brake rigging and armature clearances. The general day inspection covers the car body and fittings from bells to ventilators, the mechanical equipment from air pipes to wheel gaging and the electrical equipment from armatures to the light switches. Twenty-seven items are reported upon under "car body," twenty-eight items under mechanical equipment and twenty-four under electrical details, the inspection work being specialized under the above headings. All of the seven cars held for the daily thorough inspection are released for service the following day. Practically no night repairs are made at the shops other than minor replacements and adjustments.

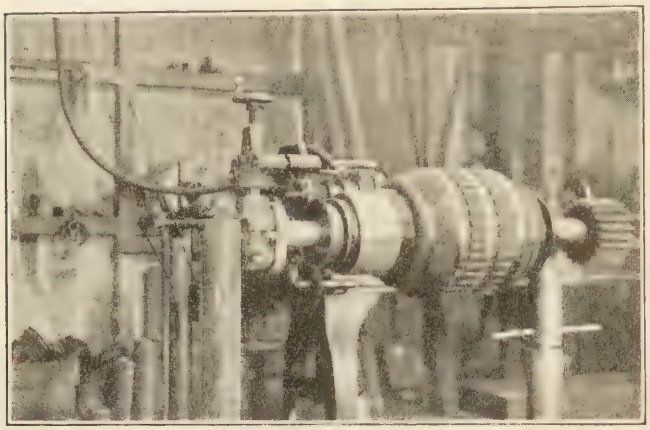
Armature clearances are tested by a template composed of three sheets of fiber riveted together at one end, three thicknesses being inserted in new equipments and two in worn motors. The bearings are changed when only one thickness of fiber will pass between the armature and the pole piece. The standard factory clearances are maintained so far as possible. Broken motor cases and frame parts are welded outside the shops by the autogenous or oxy-acetylene method.

OVERHAULING SHOP

The overhauling shop, 90 ft. in width, adjoins the pit room on the street floor. The motor and truck bay is situated at the east end with excellent natural light and hoisting facilities. A row of stock bins about 60 ft. long

has been built along the wall at the end of the room near the track terminals. Bolts are distributed in bins according to the sizes marked on the outsides of the latter, old bolts being cut off and rethreaded to save stock and the cost of making new ones.

Two of the overhauling tracks have 35-ton Columbia car hoists of 5-ft. travel. Each hoist has two 12-in. steel



Worcester Shops—Commutator Slotter

I-beams paralleling the rails and raised and lowered by shafts geared to the motor trains. By placing a pair of rails under the sills at right angles to the track a car is hoisted above the previously disconnected brake rigging and motor leads. A car can be disconnected by two men in about ten minutes and raised off the trucks in a total of twenty minutes from its arrival, compared with at least fifty minutes for jacks or blocks and falls. The shop also has a 2-ton pit hoist driven by a 2-hp, 550-volt d.c. motor, the hoist being provided with a 19-ft. boom and chain control from the floor level. A hand-operated hoist with an 8-ft. boom is located on the south side of the truck shop to transfer heavy parts to the blacksmith shop adjoining.

MACHINE SHOP AND BLACKSMITH SHOP

The machine shop contains a Putnam No. 2 boring mill, a 150-ton Schaffer hydraulic wheel press, a Putnam wheel-turning lathe with 38-in. swing, a 16-in. swing Reed lathe, two 22-in. Blaisdell engine lathes, radial, sensitive and upright drills, a Stockbridge shaper, a Powell 72-in. x 24-in. planer and a Putnam No. 2 milling machine. The wheel-turning lathe is gear-driven by a 25-hp, 550-volt individual motor, the control providing for sixteen forward and four reverse speeds. All the other machines except the latter are group-driven by a 15-hp motor. The wheel lathe is served by a 1½-ton Yale & Towne hoist, and the shop has overhead hoisting facilities with runway for transporting heavy material from the elevator to the tools. A 21-in. gage track connects the machine and blacksmith shops. A small tool room is in service in the machine shop as a part of the foreman's office. Register, air-brake, compressor, wheel and truck repairs which require machine work are handled in the machine division.

The company buys all axles in the blank form, turning them to the standard sizes from the rough stock. Worn axles are utilized as material for armature shafts. Other work includes the purchase of air-brake pump bushing castings and their boring to size, and the boring out of various types of bearings. All overhead frogs and line switches are finished in the shop. No castings are made on account of the large development of commercial foundry work in Worcester. The company manufactures its own electric track switches, machining the castings from patterns built in its wood mill. Steel wheels are turned when signs of flange wear begin to appear, the limit in diameter being 31 in. Flat spots are ground out of the cast-iron wheels used on the city cars by the pit grinders.

The blacksmith shop contains three large forges and a babbitting furnace, two fans for forge blast and withdrawal of smoke and a trip-hammer and set of power shears group-driven by a 15-hp motor mounted on an overhead platform. This motor also drives several machine tools in the winding room above. The babbitting outfit includes a mold for pouring four bearings at one time. Armature bearings are babbitted with a dust cap on the end of each. Arbors are withdrawn after the metal has been poured by placing the shells on a table equipped with air plungers controlled by brake valves, the pressure on the plungers quickly withdrawing the most tightly fitting arbor.

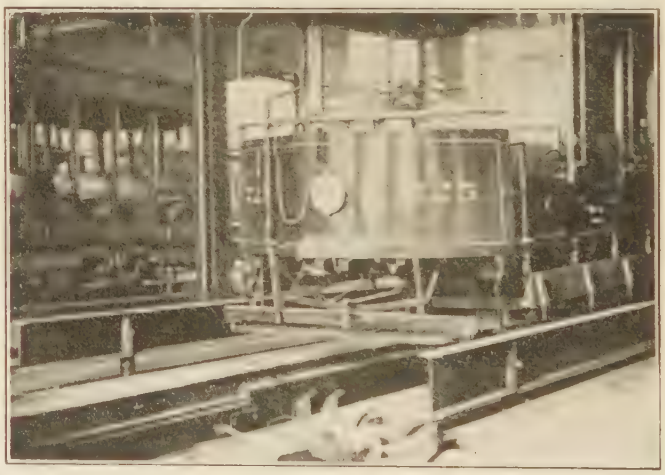
STOREROOM

The storeroom receives material either by team on the School Street side or by service car brought into the building and delivered near the issue window or interior receiving doorway. A hand-operated crane is located near the delivery window. Near by is a bin to receive scrapped trolley wheels before new ones are issued. With the exception of wheels and gears and other heavy material kept in the cellar, all material is delivered only upon requisition. A signal bell with push-button is installed at the delivery window to save time. When a wheel is used it is reported to the storekeeper by the man who has pressed it upon the axle. The issue of lubricants is also recorded by the storekeeper.

Supplies are delivered and scrap collected by a stock car which is equipped with four 40-hp motors. This car has a length over all of 30 ft., body width of 7 ft. 6 in. and width over steps of 8 ft. 10 in. It makes trips at stated times to various carhouses, power house, etc.; and also at frequent intervals to Greendale, in northern Worcester, where all heavy line and track material is received by rail and stored for future use. It has been found much more economical to have regular trips than to make spasmodic collections and distributions.

ELECTRICAL SHOPS

The winding room, 224 ft. x 23 ft., is located on the floor above the machine and forge shops, with a frontage on the School Street side of the property. At the west end is a small sub-storeroom for brushes, commutator fittings, etc. The entire winding room is served by a ceiling runway, two 1-ton Yale & Towne hoists being utilized upon it to transport armatures over eight spurs to tools and bench stands. All heavy material is brought into the department



Worcester Shops—Car Hoist

by the electric elevator previously mentioned. On the south wall are benches for controller repairs, rheostat, headlight and compressor armature maintenance; the opposite side is for temporary storage and the taping and varnishing of compressor armature coils, which are made by the company's forces.

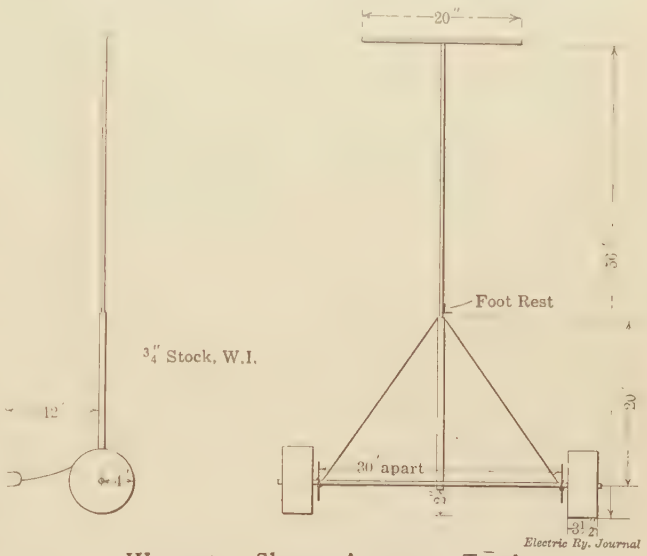
The electric oven for drying coils is equipped with six

cast grid resistances housed in a sheet-iron box 9 ft. long, 3 ft. wide and 3 ft. 8 in. high. End racks are provided for holding field coils, while seven semi-circular openings in the sides at the top enable as many armatures to be inserted simultaneously. The dip tank with chimney leading to the roof is fireproof. The company does not make railway motor armature coils, but rewinds defective armatures with coils purchased from manufacturers. All stands for specialized service are supplied with artificial illumination by groups of five 16-cp incandescent lamps mounted beneath portable reflectors.

A special bench is utilized principally for heater coil rewinding and circuit-breaker repairs, including tests. A 2-hp, 550-volt direct-current motor drives a grinder and a lathe for heater coil winding at this bench. This room also has a nine-compartment rack for brush-holder storage, a lathe belt-driven by a 2-hp motor for coil winding, an armature shaft and commutator turning lathe and a Columbia banding machine with friction drive. The small lathe motor originally had a 2½-in. x 2-in. pinion, but the company has adapted it to belt driving by placing a ⅛-in. leather ring on the pinion circumference, thereby providing a pulley. The testing equipment embraces a lamp bank with adjustable connections for testing commutator insulation and armature coil resistance, a milli-voltmeter and a Westinghouse transformer for testing insulation at potentials varying from 100 volts to 2000 volts.

The commutator slotter used here is direct-connected through a shaft and universal joint to a 2-hp motor, the cutter being 1¼ in. in diameter and adjustable for height by means of a screw shaft and handle which controls the tool head. A compressed air hose carries the mica cuttings away from the operator. Commutators are undercut about 1/16 in. They are protected by sleeves of cardboard when shipped from the winding room to outlying carhouses.

Among the labor-saving devices in use is an armature truck of the skeleton type shown in the sketch on this page. This truck has two 8-in. wheels with 3½-in. treads and a 20-in. handle carried 56 in. from the floor at the top of a ¾-in. wrought-iron bar carried to the center of the wheel shaft. A foot rest is provided on the main bar 20 in. above the floor. The armatures are carried on U-shaped holders forged at the ends of extension pieces 12 in. long. The truck design permits the handling of armatures on the cantilever principle, and the balancing of the equipment is one of the convenient features of this home-made device.



Worcester Shops—Armature Truck

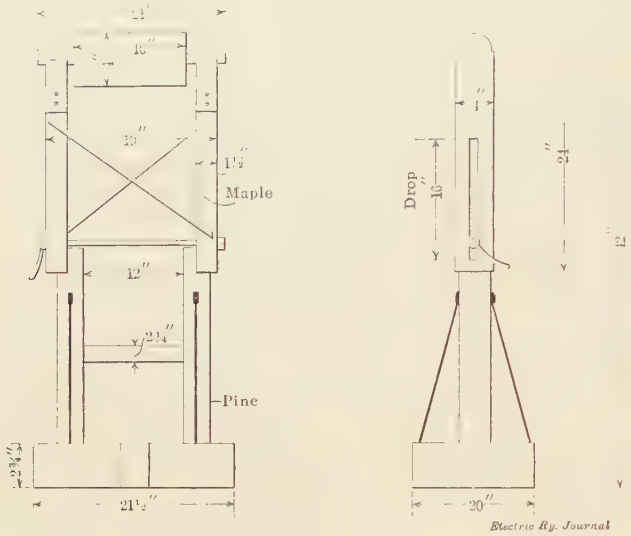
MILL ROOM

The mill room is approximately 71 ft. long x 55 ft. wide, on the second floor of the shop building, where it has ample skylight area. Its tools include one band saw, one straight molder, one cutting-off saw, one buzz planer, two turning lathes, a Woods novelty molder, one Woodbury hollow-chisel mortiser, one tenoning machine, a circular saw, swing saw and small planer. The mortiser has a range of cuts from ¼ in. square to 1½ in. square. The novelty molder has two heads and a 12-in. drop. The swing saw, a grinder, an emery wheel and a 36-in. blower, besides two lathes for woodworking, the tenoning machine and a boring machine, are group-driven by a 35-hp, 550-volt motor, while the rest of the equipment is group-driven by a 110-hp motor. The blower operates a duct system for the removal of sawdust from the various tools. Outlets from 4 in. to 6 in. in diameter carry the shavings and sawdust from each machine to a 16-in. trunk duct which leads to the roof, and thence to the boiler house after a run of about 300 ft. and a passage through a separator which deflects the material from the entrained air. The sawdust discharge system has

Worcester Shops—View of Winding Room

a floor suction pipe which takes care of all debris swept below the pipe outlet, the latter being bent down in U-shape to a clearance of about 4 in. above the floor.

The work of the wood mill covers a great variety of repairs to car bodies and furnishings, including the complete



Worcester Shops—Lumber Roller for Wood Mill

rebuilding of damaged parts, the manufacture of floor matting, seats, advertising racks, posts, side sills, bolsters, vestibules, sheathing, grab-handles, rails and many other details of rolling stock equipment. The mill room has compressed-air outlets for cleaning the machines. Lumber is stored temporarily on an overhead platform, which is separated from the setting-up shop by a 10-in. brick firewall. In order to reduce the ingress of heat in the summer, the skylight of the mill room is painted white annually in advance of the warm season.

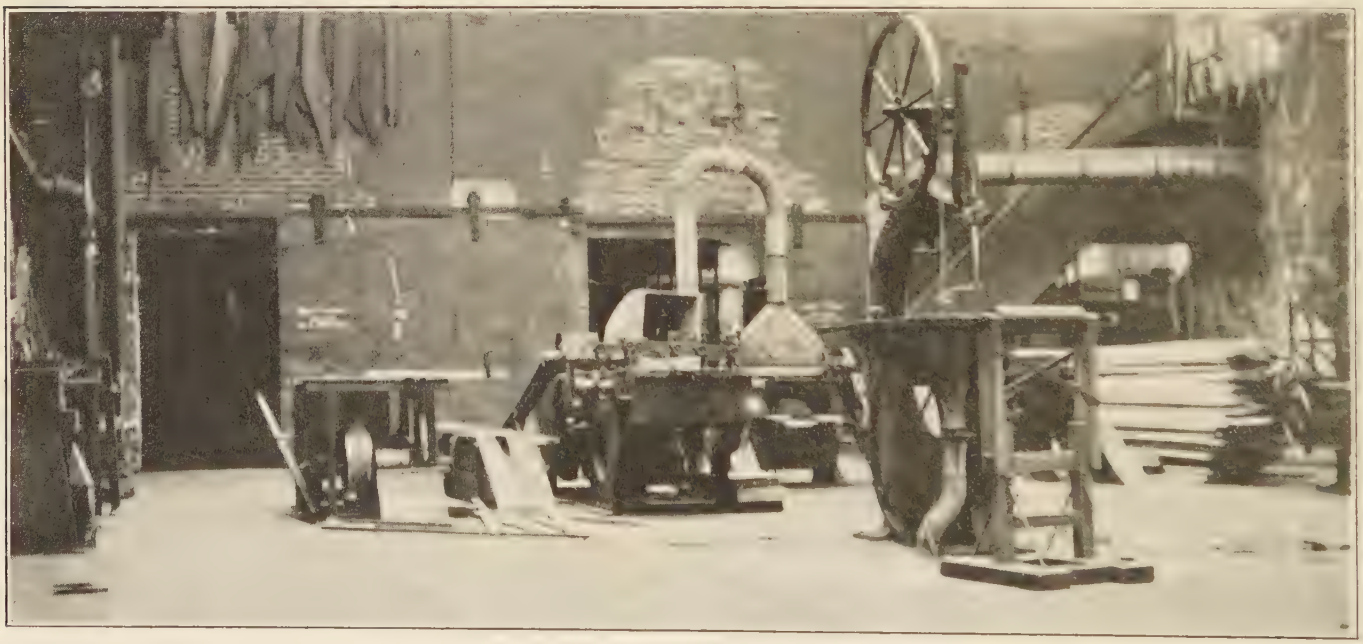
To facilitate the handling of long timbers, two horses with roller attachments have been developed by the foreman of the department. As shown in the sketch on this page, each consists of a 16-in. oak roller, 4 in. in diameter, supported on a maple and hard-pine adjustable frame having a range of 16 in. in height above the floor, the frame being locked in position by a hand-turned bolt at any desired point.

MISCELLANEOUS SHOPS

The setting-up shop, 107 ft. long x 73 ft. wide, adjoins the wood mill. It is used mainly for car-body repairs. A 30-ft. x 49-ft. auxiliary machine shop containing a drill for work on metal sills and other car-body fittings is located at one side of this sub-department. The pattern storage room, which is about 15 ft. square, is near the wood mill. Formerly the company left its patterns at the various foundries, but it now requires all patterns to be returned with the castings, thus retaining a far better control of the cost of foundry service.

Worcester Shops—Sawdust Disposal Duct from Millroom

The paint shop is a well-lighted area at the east of the setting-up shop and contains ten tracks. Adjoining the shop are a fireproof storeroom for paints and varnishes, 40 ft. x 61½ ft., a varnishing room, lumber room and sign storage quarters. Sashes are kept in a special rack with movable framed drawers. End and side signs are painted in a special room which is equipped with racks, stencils, templates and other articles of similar nature.

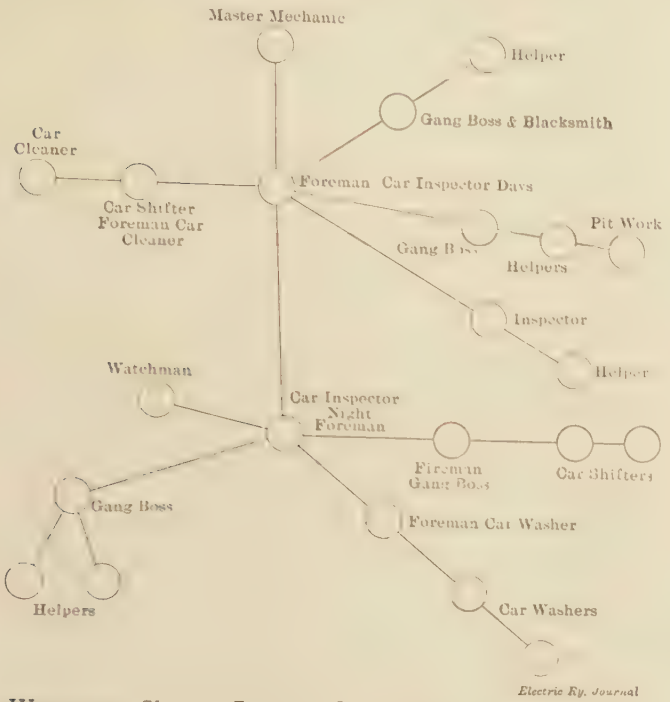


Worcester Shops—View in Millroom, Showing Shavings Exhaust Piping

AUXILIARY SHOPS AT CARHOUSES

The various carhouses have small auxiliary machine shops usually containing a hydraulic pit jack and an engine lathe, drill and grinder group-driven by a 10-hp, 550-volt d.c. motor. In several cases a forge is also available. The largest carhouse proper is located at Gates Lane, about 2½ miles south of the center of Worcester. It has a

capacity of about 170 cars. The work at this house covers inspection, the replacement of electrical parts, small body fittings, register rods and light repairs on brake rods and trucks. At night only light inspection is carried out. The blacksmith shop contains a grinder, circular saw, air com-



Worcester Shops—General Organization Diagram of the Gates Lane Carhouse

pressor and engine lathe, all electrically driven. A subStoreroom carries lighter supplies. In this room a 30-in. x 36-in. bulletin board of "Closed Cars Left in for Daily Inspection" is in service, the record of each car being kept by a tag 1 in. in diameter which is attached to a pin corresponding to the date at which the car is due. Longer pins are inserted in the record squares when cars fail to appear at the appointed date. The pit equipment at Gates Lane includes a 3000-lb. hand hoist with 8-ft. boom. Seven cars are inspected daily at Gates Lane, the smaller houses taking care of about three cars daily. At night inspection for brake conditions and armature clearance with other external examination is performed on fifty cars at Gates Lane and on twenty cars in each of the other outside houses.

FIRE PROTECTION

The Gates Lane carhouse is protected by Rockwood sprinklers operated upon city high-service water pressure. Aisle sprinklers are used besides the overhead equipment. Each side of each car is protected by a line of sprinkler heads carried 8 ft. above the rail and 12 in. from the car. The double lines of distributing pipes between tracks are 24 in. apart. The heads are generally 8 ft. apart. Fire hose and chemical extinguishers are also in service. For the fire protection of the Market Street shops a watchman's clock system, Grinnell sprinklers, fireproof partitions, fire doors, dry powder and chemical extinguishers and hose are installed. In practically all departments care is taken to sweep the floors at least twice daily. Paint and other inflammable storage is handled so far as possible in isolated fireproof structures.

RECORD SYSTEM

Few shops of like size have such extensive records as Worcester. The standardization of rolling stock especially has required the preparation of many engineering data, a large number of which are available for carhouse and shop reference. The International time recording system is used in all mechanical departments. The "in" and "out" time slip of each man is "O.K.'d" by the department foreman and sent to the master mechanic's office. This record is checked by the foreman's weekly report concerning the kind of work performed by each man, his rate and hours of service. The list of regular reports forwarded to the master mechanic follows:

Daily Carhouse Reports:
- Time slips.
- Defective car service reports.
- Cars and condition of each left in carhouses at 6 a.m. and 6 p.m.
- Report of cars transferred to different houses.
- Motormen's defective car sheets.
- Report of non-revenue mileage.
- Number of cars in each at 2 a.m. nightly.
- Record of defective car service reports.

Daily Shop Reports:
- Time slips.
- Estimate on overhauling cars.
- Final estimate of cars overhauled.
- Number of cars painted and varnished daily.

Daily Reports from Stockroom:
- Report of new material received.
- Requisitions of stock used daily.

Monthly Reports:
- Record of scrap wheels from all carhouses.
- Record of defective wheels from all carhouses.
- Report of derailments.
- Amount of oil used in all houses.
- Axles scrapped.
- Steel wheels scrapped.
- Record of armature shafts and axles made in machine shop.
- Record of steel wheels turned.

Weekly Reports:
- From winding room, report of all armatures repaired and rewound for week, with cause of trouble.
- From inspector of carhouses and sprinkler systems.
- From carhouse foreman, report of changes in electrical equipment.
- From above, reports of tests, broken axles, and hot journals.

A record of car pull-ins, that is to say for cars taken off scheduled runs, is kept, with the detailed cause of each trouble. This information is incorporated daily by the carhouse foreman on the defective car service report blank. All defects are listed and receive a corresponding number, forty entries being provided for on the blank form, and the detailed causes of trouble are written under the heading "Remarks." Copies of the report are sent daily to the master mechanic and by him a duplicate is forwarded to the general manager for approval and transmission to the engineer of power and equipment.

In the master mechanic's office a monthly record of defective car service is prepared from the daily reports, all troubles being set down for each car under the day of the month in which the defects occurred, the forty principal

Worcester Shops—Car Bulletin Board, Gates Lane Carhouse

entries being listed according to number. This record enables any recurrent trouble on a car to be quickly detected. The defects are compared for every carhouse on a monthly basis, the results being plotted on a diagram and filed in a loose-leaf book. A typical diagram on page 574 shows the gradual decrease in pull-ins per 1000 car miles run at the Market Street and Gates Lane houses in Worcester during

the year 1911. The defects are analyzed in detail at the monthly meetings of carhouse foremen. The results of the defect record system are now apparent in the reduction of the number of pull-ins.

Worcester Shops—Pull-in Record

Among the other report blanks used are a form for recording noted defects on cars turned in at night but which do not cause a pull-in, a report on the transfer of any electrical equipment or trucks from one car to another, weekly changes in payroll, consumption of oil, report of wheels removed and installed, and a detailed estimate of the cost of repairs on cars brought into the shop after an accident. No repairs are allowed on such cars until an estimate of labor and material required to make the damaged part good has passed the master mechanic and general manager and has been authorized by the engineer of power and equipment at Springfield. Upon conclusion, the detailed actual cost of the work is presented to the general manager and engineer. Great care is also taken to secure full details on all broken axles, about a dozen main items being reported on a special sheet to the master mechanic. This information is combined with chemical analyses.

Other records include the report of the fire-risk inspector, wheel-turning record, card index data on car equipment, wheels, axles and armatures and armature shipping tags, also individual shopman's daily record slip, based on number of car upon which work is performed, which is sent to the master mechanic through the department foreman.

All carhouses and shops on the Worcester system are supplied with the following books containing data on standardized equipment: Books of axles, coil springs and elliptic springs, and blueprints of pattern numbers for brakeshoes and heads, standard air piping, standard car lighting and

Report on a Broken Axle.

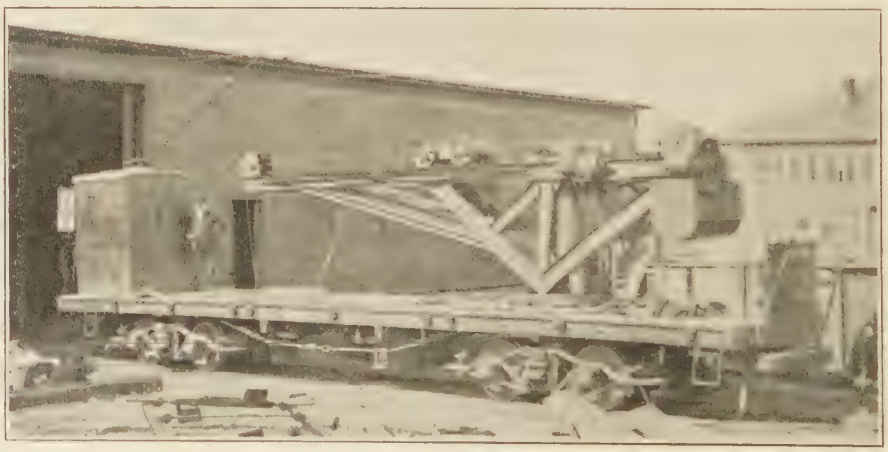
Date,	*February* 5, 1912.
Car No.,	622.
Type of motor,	*G.E.*-80.
Type of truck,	*Taylor*
Kind of axle,	*Cold-rolled steel.*
Diameter of journal,	3¼-*inch.*
Length of hub of wheel,	5¼-*inch.*
Type of car,	*Double-truck closed.*
Break,	*In keyway.*
Axle No.,	1573.
Diameter of wheel fit,	4-*inch.*
Date installed,	*January* 4, 1912.
Order No. purchased on,	103-26.

Worcester Shops—Items Specified in Report on a Broken Axle

standard brake rigging. This information has been found of the highest value both in the ordering of supplies and the accurate assembling of partially dismantled rolling stock. The axle book, for example, gives the company's drawing number for every axle required in mounting every type and size of railway motor used on its lines, and a separate drawing 8 in. x 12 in. in dimensions, showing all dimensions of each axle. The book on springs presents like details.

The master mechanic has a book of pull-ins showing the behavior of specific motors on given routes. The storekeeper also carries a book which now has 903 different patterns. It shows by number, title and page the listed drawing of every pattern, each drawing being filed in the book by number. An extra copy of the pattern book is kept in the master mechanic's office. This information is of great value in preventing the ordering or delivery of the wrong castings, and furnishes to the storekeeper a means of checking demands for spare parts.

A chart is kept in the main office of all cars expected for inspection at specified dates, these cars being checked as fast as they are handled. Three plug boards, two of which are in the form of table drawers, are used to keep track of all closed, open and suburban cars and their location as regards carhouse headquarters. One plug board, 34 in. x 35 in. x 2¾ in., is placed on the wall of the master mechanic's office to show the location of every car which is in storage at any particular time. Plugs are used to show the different carhouses, and under each of them colored plugs, numbered to correspond to the cars normally using these houses, are placed. No car can be shifted from one house to another without a report to the master mechanic and a subsequent



Worcester Shops—Electrically Operated Derrick Car

change of the plug board. The plug boards in the table drawer installation are each 28 in. x 40 in. in dimensions, and are equipped with colored plugs of the selected shades, with spacing plugs to represent the carhouses. One drawer is for suburban cars and the other for closed cars operated

in city service. All show at a glance the location of every car on the system.

Mail to and from the master mechanic's office to the several carhouses is handled in 10-in. x 4¼-in. waterproof folders made of discarded curtains, each provided with a 3½-in. x 1¼-in. cloth tab with the master mechanic's address on one side and that of the carhouse foreman on the other. These folders save writing by the simple expedient of tying back one side or the other of the address tab. Most of this mail-pouch service between departments is handled on the company's own cars.

DERRICK CAR

Heavy material received via steam railroad is unloaded at the Greendale yards, where a large storage carhouse is located. At this point is stored the new Wason derrick car

Worcester Shops—Plug Boards for Car Records Used by the Master Mechanic

shown on page 574. It consists essentially of a heavy flat car, 46 ft. 4 in. long over all and 8 ft. 5½ in. wide, mounted on two Wason trucks of 5-ft. wheelbase installed 25 ft. centers; four G-E-80 40-hp motors, and a Whiting three-motor cantilever crane having a lifting capacity of 3 tons at a radius of 21 ft. The counterbalanced hoist is driven by an 11-hp motor, a 2-hp motor being supplied in each instance for the operation of the swing and traverse motions. The car also has "K35-G" controllers, General Electric air brakes, interior and outside incandescent lamps, fenders, hand brakes and Murphy sanders. With a gear ratio of 19:67 this derrick car will run at a maximum speed of 20 m.p.h.

MANAGEMENT

The rolling stock maintenance work on the Worcester system is in charge of A. J. McPherson, master mechanic, reporting to Henry C. Page, general manager. P. W. Ripple is engineer of power and equipment, and J. T. Harmer vice-president of the New England Investment & Security Company.

LIFE OF ELEMENTS OF SUBWAY PROPERTY

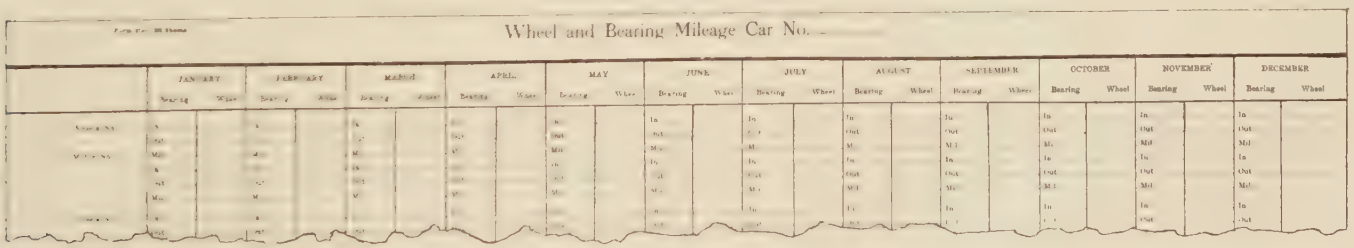
E. G. Connette, transportation engineer, New York Public Service Commission, First District, testified before the commission recently in reference to the subject of depreciation in the case in which the Interborough Rapid Transit Company of New York asked for authority to issue bonds for additions to the property. Mr. Connette said that he had prepared an estimate of depreciation as applied to the elements under consideration on the straight-line theory, estimating the life of copper-sheathed cars at thirty years, steel cars at forty years, buildings and fixtures at fifty years, and power plant equipment at thirty years. He then ascertained the number of years that these particular elements had been in service and figured the annual depreciation of each. This was assumed upon an age of copper-sheathed cars in service of seven years; of steel cars, a portion for six years and a smaller number for five and a half years; buildings and fixtures, seven years; power plant equipment, five years.

In another estimate Mr. Connette assumed the same life for the various elements that were included in the foregoing and made a computation of the amount per $1,000 that it would be necessary to set aside annually at 4 per cent compound interest to amortize the various items of property at the end of the life periods assumed. This computation showed the annual amount necessary for each class of property and the total which would accrue in a sinking fund at the present time on that basis.

Mr. Connette added that to his knowledge this method of treatment of depreciation had never been adopted or approved. It applied particularly to the amortization of securities and it was assumed that the fund would not be distributed during the entire life period of the property involved. He thought he had allowed a very liberal life for the various parts. Some of the property might have to be replaced or possibly be displaced for some reason before the end of the periods which he had assumed. In those cases recourse would have to be had to the fund, and then the computation would be disturbed and the amount fixed as necessary to replace the property at the original value at the end of the period would not be realized.

WHEEL AND BEARING MILEAGE FORM AT MEMPHIS

A form used by the Memphis (Tenn.) Street Railway to record the wheel and bearing mileages is shown in the accompanying illustration. It provides sufficient space for the records of one year. Lower, on the same form sheet, a daily record is kept of the mileage run by each car. The car mileage is totaled on the date a bearing or wheel is put in service, and this figure is entered under the wheel or bearing head on the proper line. At the same time the wheel or motor number is recorded. When the part is renewed the car mileage is again totaled and recorded. The difference between the two car mileages furnishes the record of the miles given by the part in question.



Memphis Wheel and Bearing Mileage Record

The fact that the whole record of a car's performance for one year is found on one sheet is very convenient and at the same time the amount of clerical work is reduced.

Piece-Work and Bonus Systems in Interborough Rapid Transit Company Shops

Methods of Payment Introduced in the Shops of the Elevated and Subway Divisions Mutually Beneficial to the Employees and the Company—Results Are Shown by the Lists of Piece Prices on Various Items

Improved methods of payment for work in car maintenance shops of electric railways are sometimes believed to be impossible of installation. However, the fact that this is by no means true has been amply demonstrated during the past few years by the Interborough Rapid Transit Company. This railway, under whose management are the elevated lines and the subway in New York City, naturally takes a leading place in the field of investigation and experiment in electric traction, not only on account of its size, but also on account of its policy. One phase of the constant effort on the part of the Interborough officials toward cutting out lost motion and unnecessary work is shown in the labor costs which are represented in the abstracts of the piece-work and bonus schedules submitted in this article. Most of the prices cover operations which, if not the equivalent of, are at least comparable to those carried on in many electric railway shops, and they serve as an indication of proper values of work in any place. Compared with costs of similar work carried on under usual conditions they substantiate the statement of the Interborough officials that the cost of any ordinary job can be cut at least in half by eliminating unnecessary motions and paying only for useful work.

It should not be understood by this that it has been the policy of the Interborough officials to obtain the last ounce of energy of which a workman is capable. In fact, the prime object in view at the inception of the new systems of payment was to increase the shopmen's wages in order to obtain the services of men of skill and experience in their own lines. It is, of course, necessary in introducing any improved method of wage payment to obtain and hold the absolute confidence of the shop force in the honesty and desire for fair dealing on the part of the management. Prices for piece work after being established on the basis of a time study are never cut by the Interborough unless new methods for doing the work are developed. The management, however, endeavors to limit the amount of money which a man can earn for the reason already stated that it does not desire to have men work at an extraordinary pace and create too keen a competition in the shop. What it does want is to eliminate lost motion and wasted effort.

Constant attention to the latter subject is rapidly resulting in the practical abolition of payments on the hourly basis for all routine work carried on in the car maintenance departments of the Interborough company.

For routine operations of a simple character, constantly repeated and capable of close analysis as to best methods of performing the work as well as the proper price to allow for it, payments are invariably made by the piece. For the more complicated operations involving possibility of differences in the amount of work required in different jobs of the same kind the bonus system is used. At present the latter method of payment is used for car cleaning, truck stripping and assembling, motor stripping and assembling, motor wiring, manufacturing of standard material, all operations in the wood mill and installations of new equipment in the cars.

Under both systems of payment proper prices for work are set generally by a "key" system. This in effect amounts to separating each complete job into the elementary operations which go to make it up and which are performed in exactly the same manner although not necessarily to the same extent for every job. The elementary, or "key," prices, when once determined, can be applied to make up the proper price for any job by simple arithmetical combinations. "Key" prices are, of course, applicable only to the shops for which they are determined, and, in fact, should only be used in making prices under the directions of the person who establishes them.

As an example, however, of the manner of establishing a price upon work which is a strictly manual operation, or, in other words, does not involve the use of machine tools, the piece price table for stripping and trimming the four classes of subway cars used by the Interborough company is shown in Fig. 1.

Before this table was prepared the work of stripping and trimming was carefully studied. All unnecessary oper-

Subway Cars—Strip and Trim

Items.	Number of Pieces or Screws.				Price for Stripping.					Price for Trimming.				
	Copper, Motor.	Copper, Side Doors.	Steel, No Side Doors.	Steel, Side Doors.	Key Price to Strip.	Copper, Motor.	Copper, Side Doors.	Steel, No Side Doors.	Steel, Side Doors.	Copper, Motor.	Copper, Side Doors.	Steel, No Side Doors.	Steel, Side Doors.	Key Price to Trim.
Windows	28 pcs.	24 pcs.	28 pcs.	22 pcs.	.00430	.1404	.1032	.1204	.0946	.....	.....	.....	.....	.....
Sash stops	448	384	420	368	.00045	.2016	.1728	.1890	.1656	.9408	.8064	.8820	.7728	.0021
Sash locks	260	240	288	240	.00045	.1170	.1080	.1296	.1080	.5460	.5040	.6048	.5040	.0021
Sash ratchets	364	308	336	...	.00045	.1638	.1386	.1512	.....	.7644	.6468	.7056	.....	.0021
Sash catches	16	48	24	48	.00045	.0072	.0216	.0108	.0216	.0336	.1008	.0504	.1008	.0021
Sash rods	32	60	32	64	.00080	.0256	.0480	.0256	.0512	.0480	.0900	.0480	.0960	.0015
Cab door sash locks	...	...	16	16	.00045	.....	.....	.0072	.0072	.....	.....	.0336	.0336	.0021
Cab door sash molding	...	...	12	12	.00045	.....	.....	.0054	.0054	.....	.....	.0252	.0252	.0021
End door curtains	...	...	8	8	.00080	.....	.....	.0064	.0064	.....	.....	.0256	.0256	.0032
Seat backs	32	32	52	32	.00120	.0384	.0384	.0624	.0384	.1056	.1056	.1716	.1056	.0033
Notice frames	10	10	18	20	.00080	.0080	.0080	.0144	.0160	.0320	.0320	.0576	.0640	.0032
Bells	12	12	8	12	.00080	.0096	.0096	.0064	.0096	.0384	.0384	.0256	.0384	.0032
Vestibule sash lifts	...	16	...	...	.00045	.....	.0072	.....	.....	.....	.0336	.....	.....	.0021
Cab doors	98	...	...	...	.00120	.1176	.....	.....	.....	.2058	.....	.....	.....	.0021
End doors	46	32	...	...	.00120	.0552	.0324	.....	.....	.0966	.0672	.....	.....	.0021
Fire extinguishers	...	4	...	2	.00080	.....	.0032	.....	.0016	.....	.0128	.....	.0064	.0032
Signal cords	2 pcs.	4 pcs.	4 pcs.	4 pcs.	.02600	.0520	.1040	.1040	.1040	.1940	.2560	.2560	.2560	.0640
Sort trimmings	...	...	...	...	.....	.....	.....	.....	.....	.2040	.2040	.2040	.2040	.2040
Totals	...	...	...	...	.....	.9364	.8010	.8328	.6296	3.20920	2.8976	3.0900	2.2324	
Piece price per car	...	...	...	...	.....	$0.94	$0.80	$0.85	$0.65	$3.20	$2.90	$3.10	$2.25	...

Fig. 1—Interborough Wage Systems—Key System of Making a Piece Price

ations were eliminated and the most efficient methods of doing the work were thought out and introduced. During the preliminary study it was found that the bulk of the useful work done in stripping and trimming consisted in removing and putting in wood screws. Furthermore, it was observed that the time and effort applied by a carpenter with an automatic screwdriver in removing a screw were exerted in starting it, and that in putting in a screw the bulk of the work was done in the last few turns as it was set solidly into place. In consequence the size of the screw had little effect upon the time required to extract or insert it. This fact established a basis for the "key," which was made the time required to extract one screw for stripping and to insert one screw for trimming. The exception to this existed in the labor of removing sash from the frames and piling them in the car. This item was found to require an appreciable time interval, and, since the number of screws per sash was not constant for all types of car, the labor cost of removing the sash could not properly be apportioned among the prices allowed for each sash screw. The labor cost for removing sash was consequently made a separate item, as is shown at the top of the table in Fig. 1.

While it was found that the cost of extracting or inserting screws was to some degree independent of the size, the matter of the location of the screw was found to exert a large effect. Screws for seat backs were much more difficult of access than those for sash locks and in consequence a proportionately higher cost per screw existed.

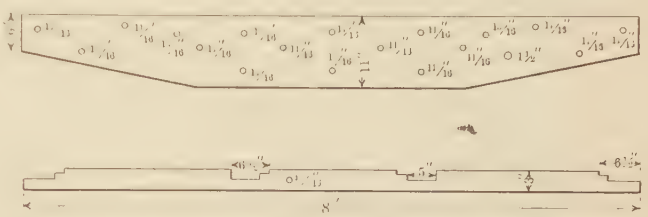
The "key" prices for the various classes of screws were established by timing a large number of operations carried on by a carpenter of average ability. All work except that strictly applicable to the "key" price was rigidly excluded and no rest periods were considered. By summing up the series of times taken for the screws of each class, and by dividing the total time by the number of screws for each class, the time required for extracting or inserting one screw was obtained. This time included the work of removing or replacing the piece held by the screws, except the windows as previously mentioned, but it did not allow for any rest period between operations. The proper amount of rest was set at 33⅓ per cent of the actual working time and this was included by increasing by one-third the day rate from which the key price was calculated. The day rates for stripping and trimming at the time these key prices were made up were respectively 21 and 24 cents per hour, so that when the unit times for removing and inserting screws were determined the key price per screw was calculated by multiplying the unit time by a rate of 28 cents per hour for stripping and 32 cents for trimming.

As shown in Fig. 1, the key prices thus obtained ranged between $0.00045 and $0.00120 per screw for stripping and $0.0015 to $0.0033 per screw for trimming. In working up the table the number of screws in the various trimmings of one car of each type were counted and listed, as shown in the four columns at the left-hand side of the table. Then the number of screws in each class was multiplied by the corresponding key price as shown and the results were tabulated under the headings "Price for Stripping" and "Price for Trimming." The totals, including a unit price for removing and applying signal cords and for sorting trimmings, gave the price per car. The actual piece prices paid for each class of car were for the sake of convenience given in round numbers.

The result of the introduction of this piece price was to reduce the cost of stripping and trimming to approximately 40 per cent of the cost existing under day-work payments, notwithstanding that the wages of the workmen were increased about 40 per cent.

An example of the application of the "key" system to machine operations is given for the platform end sill of which a sketch is shown on the price sheet; see Fig. 2.

All of the work necessary to produce this sill can be subdivided into six general operations, the price allotted to each being shown in the lower left-hand corner of the cut. Each of these operations requires the use of a different machine or bench. They are dressing the rough timber to size in a dimension planer, cutting to length with a crosscut saw, laying out by templet, boring holes in a boring machine, making four gains as shown, and sawing the ends to line on a band saw. Of the six general operations only two, the boring and the gaining, are in any way complicated, and the details for working out the prices for these operatins are given herewith. These "key" prices, shown in Table I, are based upon an hourly rate of 36 cents. They apply to a heavy vertical three-spindle boring machine with hand-operated carriage and a horizontal gainer carrying a 5-in. head with a power-operated table 20 in. wide. The item of "Handling Material," shown in Table I, includes all labor of lifting the pieces on and off the table or carriage of the machine and includes the labor of setting the piece for the first cut. A "longitudinal shift" is a shift of the table or carriage holding the timber. A "cross shift" is a



Dress 22 ft. at .40 per m.	$ .0088
Cut to Length	.0075
Lay out	.032
Bore	.02251
Gain	.02106
Band Saw	.021
Total	.11287

Platform End Sill
I.R.T. Co.
4 per Car
Electric Ry. Journal

Fig. 2—Interborough Wage Systems—Price Sheet for Wood Mill Manufacturing

shift of the bit across the timber without moving the table. A "carriage shift" is a shift of the timber on the carriage such as moving the piece along the carriage or turning it.

Table I.—Key Prices for Boring and Gaining.

Boring machine, vertical, three-spindle, with hand-operated carriage.	
Handling material	$0.00033 per board ft.
Boring holes	.00010 per in. of depth
Longitudinal shifts	.00019 for 1-in. shift
Longitudinal shifts	.00022 for 2-in. shift
Longitudinal shifts	.00025 for 3-in. shift
Longitudinal shifts	.00035 for 3-in. shift
Longitudinal shifts	.00044 for 9-in. shift
Longitudinal shifts	.00051 for 12-in. shift
Longitudinal shifts	.00057 for 18-in. shift
Longitudinal shifts	.00069 for 21-in. shift
Longitudinal shifts	.00074 for 24-in. shift
Cross shifts	.0002 per shift
Changing bits	.0015 per bit
Carriage shifts	.0026 per shift
Gaining machine, horizontal, for heads up to 3 in. wide, with power-operated table 20 in. wide:	
Cuts (3-in. plain head), 12 cuts at $0.0006	.00720
Cuts across timber, each cut	.00060
Longitudinal shifts, 11 shifts at $0.0006	.00660

For the end sill shown in Fig. 2 these prices are applied as follows:

Boring:	
Handling material, 22 board ft. at $0.00033	$0.00726
Boring 19 holes 3 in. deep = 57 in.	
1 hole 11 in. deep = 11 in.	
68 in. at $0.0001 =	$0.00680
Longitudinal shifts, average length 6 in., 15 shifts at $0.00035	$0.00525
Cross shifts, 3 shifts at $0.0002	.00060
Bit changes, none	
Carriage shifts, 1 shift at $0.0026	.00260
Total cost of boring	$0.02251
Gaining:	
Handling material, 22 board ft. at $0.00033	$0.00726
Cuts (3-in. plain head), 12 cuts at $0.0006	.00720
Longitudinal shifts, 11 shifts at $0.0006	.00660
Total cost of gaining	$0.02106

As an indication of the way in which this method of analyzing operations has worked out in producing low costs, the piece-work prices for a number of standard operations are appended. For any shop which keeps close records of its labor costs it is probable that these prices will seem too low to permit the workmen to make even their ordinary day rates. However, it is well established in the Interborough

shops that the piece prices permit a marked increase in the earning power of the average workman. By setting the prices so as to divide the saving between the company and the man a satisfactory inducement is offered to compensate for the sustained effort and closer attention to the work which is necessary for the increase in production.

PIECE-WORK PRICES

Table II covers prices for work on the cars of both the elevated lines and the subway as indicated. A description of the car used on the elevated railway was given in the Street Railway Journal of Dec. 6, 1902, page 907. The subway cars were described in the Street Railway Journal of Aug. 22, 1903, page 264, and Oct. 8, 1904, page 634, and also in the Electric Railway Journal of March 14, 1908, page 422.

Table II.—Piece-Work Prices.

MACHINE SHOP.

Subway Cars.		
953	Motor or trailer truck pedestal, mill top	$0.20
920	Motor axle, turn and roll journal bearing, per end	.27
921	Motor axle, turn and roll motor bearing, per end	.40
924	Trailer axle, turn and roll journal bearing, per end	.24
925	Trailer or motor axle, turn wheel seat, per end	.10
926	Trailer axle, turn-off collar and turn axle for collar fit, per end	.15
927	Trailer axle, turn collar and turn and roll journal bearing, per end	.30
928	Trailer axle, turn collar and roll journal bearing, per end	.20
929	Trailer axle, turn and bore end collar to fit axle, each	.08
956	M.C.B. motor or trailer truck journal brass, rough cut	.02
935	Same, bore for babbitt, each	.03
936	Same bore, and face after babbitt, each	.02
938	Contact shoe fulcrum pin, turn, each	.16
939	Journal box, slot for pedestal, each	.13
992	Car body center casting, turn and bore, each	.30
964	Turn and bore Christensen air compressor cylinder cushions, each	1.85
994	Bore and face collaring for motor wheels, each	.12
972	New motor or trailer truck journal brass, mill both sides, each brass	.07
973	Same, bore for babbitt, per pair	.22
993	Same, chip, clean and file after babbitt, each	.035
974	Same, bore after babbitt, per pair	.10
978	Motor wheel, bore and face hub, each	.30
965	Bore new trailer wheel, 5¾-in. hole	.20
966	Turn limit groove on rim of wheel	.08
967	Second-hand motor axles, remove collar, recenter, turn journal and dust-guard bearing and roll journal bearing	1.45
958	Trailer truck journal box, mill, each	.08
959	M.C.B. truck journal brass, fit and apply	.12
988	Trailer truck pedestal truck jaw end bolt, ¾ in. x 2⅜ in., turn and thread	.012
989	Westinghouse motor housing bolt, 1 in. x 2 3/16 in., turn and thread	.02
981	Brake pin, 1 3/32 in. x 3⅝ in., turn, each	.018
982	Brake-head pin, 1 7/32 in. x 6¼ in., turn and thread, each	.026
983	Motor truck pedestal jaw bolt, ⅞ in. x 2⅞ in., turn and thread, each	.018
984	Christensen pump head, bolt, ⅝ in. x 3¼ in., turn and thread, each	.0125
985	Cross-head slide shoulder bolt, turn and thread, each	.02
Elevated Railway Cars.		
3005	Manhattan trailer axles, rough cut, face ends, turn and roll journal bearings and turn dust guard bearings	.80
3006	Turn and fit both wheel seats	.30
3000	Turn Manhattan wheels, per pair	.38
3004	Bore steel tires, including grooving for keeper rings, each	1.10

AIR BRAKE REPAIRS.

Subway Cars.		
1206	Air cocks, strip, clean, grind, assemble and test, ¾ in up to 1 in. each	.15
998	Air compressor governor, S-6, strip, clean, grind, assemble and test, general repairs, each	.40
999	Air compressor governor, S-6, light repairs, each	.25
942	Christensen air compressor, strip and clean, each	1.75
944	Christensen air compressor, assemble and test, each	3.50
943	Christensen or Westinghouse air compressor head, strip, clean, grind and assemble suction and discharge valves, per head	.50
945	Slack adjuster American Brake Company, strip, clean, repair, assemble and test	.40
950	Layout and cut gaskets for Christensen and Westinghouse air compressor, per set	.25
951	Westinghouse air compressor, strip, clean, repair, assemble and test, each	3.50
1201	Air gage, single hand, strip, clean, repair, regulate and assemble	.15
1203	Air gage, single or double hand, test and apply glass cover, each	.03
1204	Air compressor governor J, strip, clean and grind all valves, fit ring, repair electric device, assemble and test, each	1.35
968	Air hose, strip, including removal of nuts, bolts, clamps and fittings in condition to be used again, each	.015
954	Air hose, clean fittings, straighten clamps, apply gaskets, mount and test, each	.04

ARMATURE AND COMMUTATOR REPAIRS.

Subway cars.		
995	Armature and commutator, saw slots between segments, types No. 86, No. 300, No. 212 or No. 69, each	.35
1205	Armature commutator, remove burr, dust, file and polish by hand, same types, each	.35
975	Commutator, turn, two cuts, each	.15
976	Same, each additional cut	.04
916	Armature bearing lining, Westinghouse or G. E. pinion or commutator end, bore and face	.06
917	Armature bearing lining, Westinghouse or G. E. pinion or commutator end, rough cut, chip, file and cut oil grooves, each	$0.095
952	Brush holder, G. E. or Westinghouse, strip, repair and assemble, each	.18
955	Motor axle bearing lining, rough cut when babbitted to fit chuck	.06
933	Motor axle bearing lining, bore and face, per pair	.09
934	Motor axle bearing lining, dovetail	.037
Elevated Railway Cars.		
3007	Slotting armatures, saw slot, remove burr, dust and polish	.25
3008	Turn commutator and polish, two cuts	.13
3009	Turn pinion end, armature journal bearing, two cuts, file and polish	.25
3010	Turn commutator end, armature journal bearing, two cuts, file and polish, each additional cut	.15

TIN SHOP.

Subway Cars.		
914	Reline air compressor shaft lining bearing, pinion or commutator end	.03
906	Reline motor truck journal brass, size 5 x 9, each	.05
911	Reline G. E. armature bearing lining, pinion or commutator end, each	.05
912	Reline Westinghouse armature bearing lining, pinion or commutator end, each	.05
910	Reline motor axle bearing lining, per pair	.08
913	Reline motor or trailer truck journal brass, each	.02
915	Melt babbitt from motor or trailer journal brass, each	.0033

STRIPPING AND TRIMMING.

Elevated Railway Cars.		
1500	Stripping all classes of curtain cars, motors	.86
1501	Stripping all classes of blind cars, motors	1.10
1502	Trimming 12 window curtain cars, motors	3.10
1504	Trimming 16 window curtain cars, motors	3.30
1506	Trimming 16 window blind cars, motors	4.80
2500	Stripping all classes of curtain cars, trailers	.76
2501	Stripping all classes of blind cars, trailers	.94
2502	Trimming 12 window curtain cars, trailers	2.90
2503	Trimming 14 window curtain cars, trailers	2.60
2504	Trimming 16 window curtain cars, trailers	2.70
2505	Trimming 17 window curtain cars, trailers	2.45
2506	Trimming 16 window blind cars, trailers	4.35
2507	Trimming 18 window blind cars, trailers	4.40
2508	Trimming 18 window curtain cars, trailers	2.65
1600	Removing top sash from cars, per car	.05
2600	Replacing top sash on cars, per car	.15
Subway Cars.		
	Stripping copper sheathed motor cars	.94
	Trimming copper sheathed motor cars	3.20

CARPENTER SHOP.

Subway Cars.		
	Buffer timber; remove and replace top member, including dead wood and anti-climber	8.00
	Same, including both top and bottom members	10.00
	Remove and replace dead wood and anti-climber	2.00
	Remove and replace end door tie rod, including removal and replacement of necessary roof canvas and sheathing; only one rod, each	.75
	Same, for each additional rod	.50
	End door post, splice	.60
	Copper sheathing, remove and replace, per square foot	.06
	Window apron, remove and replace, per linear foot	.02

EQUIPPING ELEVATED RAILWAY MOTOR CARS

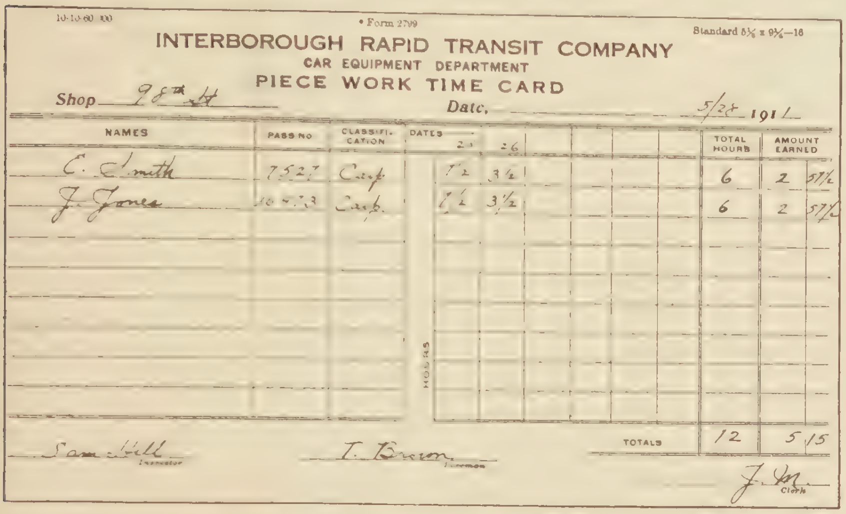
All equipment such as piping, wiring, controllers, air pump, etc., is applied by the Interborough shop forces not only for rebuilt cars but for new cars as they are received from the manufacturers. The elevated railway motor cars are of wooden construction and have one truck per car equipped with two 125-hp motors, taking current from the third-rail. The cars are approximately 47 ft. long and are equipped with train unit control and Westinghouse automatic air brakes instead of the straight air customarily used by street and interurban railways. A selection of piece-work prices for equipping cars is in Table III. The introduction of these prices effects a saving in labor costs amounting to 41 per cent for conduit and pipe work, 49 per cent for electrical work and 52 per cent for carpenter and machinists' work.

Table III.—Piece-Work Prices for Equipping Motor Cars.

7000-7020	Cut bend ream and file all conduit	$29.94
7021-7031	Install same	22.89
7034-7037	Install air piping under car	12.58
7089	Wire motor truck, not including contact shoes or fuses, per truck	4.35
7090	Same for trailer truck	.45
7091	Connect motor leads per car	.30
7092	Range contact shoes and connect shoe fuse bases	.60
7106	Set up controllers	.50
7107	Connect up same	.50
7109	Connect up heaters	1.10
7110	Put covers on heaters	.75
7113	Remove same	.35
7114	Put 100-amp. fuse base on main fuse, per car	.10
7115	Put on brass shields, apply all lamps and put in all fuses	.60
7150	Patch car body side, per patch	.12
7157	Put in third-rail shoe beams per car	2.25
7159	Put up contactor, box, per car	1.50
7160	Put up air pump, per car	1.08
7161	Put up one reverser box	.40
7167	Put up 22 heaters	1.50

Credit for work performed under piece-work rates is given by filling out cards as shown in Figs. 3 and 4.

The work on any car, or special job number, is listed on the reverse side of the sheet shown in Fig. 4, and the contract numbers identifying the various operations covered by the work under consideration are listed in the column provided for them, together with the number of pieces or operations of each kind. The contract numbers referred to are used instead of descriptions of the various operations for the sake of convenience, as each operation for which a piece-work or bonus list price is made up has a contract



10-10-60 100 • Form 2709 Standard 5¼ x 9¼—18

INTERBOROUGH RAPID TRANSIT COMPANY

CAR EQUIPMENT DEPARTMENT

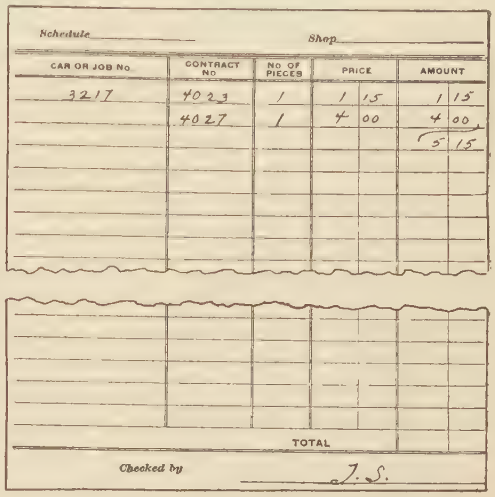
PIECE WORK TIME CARD

Shop 98th St. Date, 5/28 1911

Names	Pass No	Classification	Dates 25	26	Total Hours	Amount Earned
C. Smith	7527	Carp	2½	3½	6	2 57½
J. Jones	[illegible]	Carp.	2½	3½	6	2 57½
				Totals	12	5 15

Sam Hill, Inspector — T. Brown, Foreman — J. M., Clerk

Fig. 3—Interborough Wage Systems—Piece Work Card



Schedule ______ Shop ______

Car or Job No.	Contract No.	No. of Pieces	Price	Amount
3217	4023	1	1 15	1 15
	4027	1	4 00	4 00
				5 15
Total				

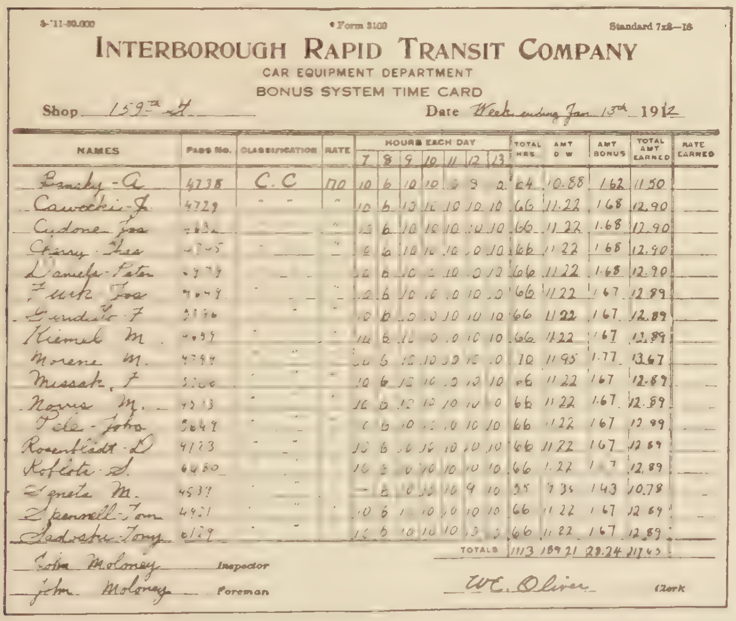
Checked by J. S.

Fig. 4—Reverse Side of Card

number assigned to it in the schedules. This contract number is permanently assigned to the operation and is used thereafter to identify it. Under the column headed "Price" in Fig. 4 the proper prices are entered from the piece-work schedule, and under the column headed "Amount" the product obtained by multiplying the various prices by the number of pieces is entered. The total of these amounts is transferred to the other side of the card as the total of the column headed "Amount Earned." On this side of the card, shown in Fig. 3, are entered the names, pass numbers and classifications of the man or men who were assigned to do the work under consideration. Opposite each man's name, under the proper date, is entered by the foreman's clerk the number of hours which each man worked on the job, and the total amount earned is divided between the men in proportion to the number of hours which each one worked on the job. The number of hours worked and the amounts earned by each man are transferred from these cards to the payrolls. The total amount earned in a week by any man is, of course, made up from a large number of these cards, together with such amounts as may be shown on the ordinary day-work time cards in case the man does not work at piece-work all of the time.

BONUS SYSTEM

The bonus system of payment for work, previously referred to in this article, is used by the Interborough company for operations which are of such a character as to prevent an exact analysis of the processes making up the complete job. This may be due to the complication of the work, to the lack of time which can be allowed for making studies, or to the lack of strict uniformity in all of the jobs. With the bonus system the possibilities for effecting unusually large savings to the company as well as for great increases in wages to the workman are not so marked as



3-'11-30,000 • Form 3100 Standard 7x8—18

INTERBOROUGH RAPID TRANSIT COMPANY

CAR EQUIPMENT DEPARTMENT

BONUS SYSTEM TIME CARD

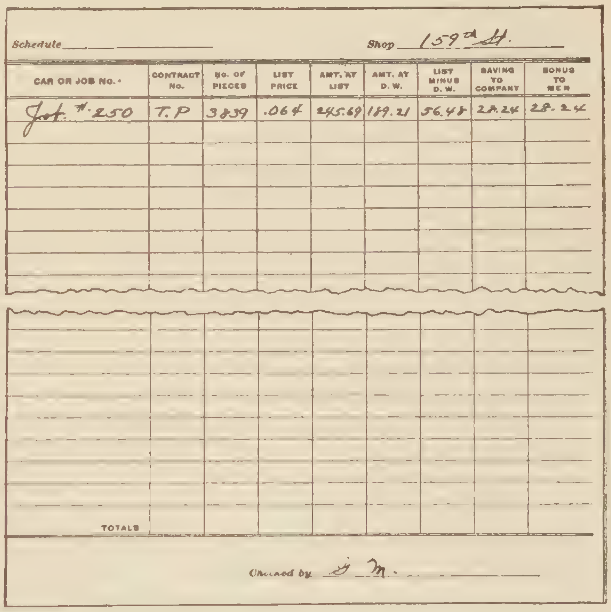
Shop 159th St. Date Week ending Jan. 13th 1912

Names	Pass No.	Classification	Rate	Total Hrs.	Amt D W	Amt Bonus	Total Amt Earned	Rate Earned
Brasky -A.	4738	C. C	170	64	10.88	1.62	11.50	
Cawecki -J.	4729	"	"	66	11.22	1.68	12.90	
Cidone Jos	[illegible]		"	66	11.22	1.68	12.90	
Cherry Thos	[illegible]		"	66	11.22	1.68	12.90	
Danielo-Peter	[illegible]			66	11.22	1.68	12.90	
Fuck Jos	[illegible]		"	66	11.22	1.67	12.89	
Gendutto F	[illegible]			66	11.22	1.67	12.89	
Kiemel M.	[illegible]			66	11.22	1.67	12.89	
Morene M.	[illegible]			70	11.95	1.77	13.67	
Missak, F	[illegible]			66	11.22	1.67	12.89	
Norris M.	[illegible]			66	11.22	1.67	12.89	
Pele-John	5649			66	11.22	1.67	12.99	
Rosenblatt D	4773			66	11.22	1.67	12.69	
Kobloto S.	6480			66	11.22	[illegible]	12.89	
Zenata M.	4537			55	9.35	1.43	10.78	
Spinnell-Tom	4421			66	11.22	1.67	12.69	
Sadoski-Tony	6129			66	11.22	1.67	12.89	
Totals				1113	189.21	28.24	217.45	

(Hours each day, columns 7 to 13, are entered for each man, mostly 10, 6, 10, 10, 10, 10, 10.)

John Moloney, Inspector — John Moloney, Foreman — W. E. Oliver, Clerk

Fig. 5—Interborough Wage Systems—Bonus Card



Schedule ______ Shop 159th St.

Car or Job No.	Contract No.	No. of Pieces	List Price	Amt. at List	Amt. at D. W.	List minus D. W.	Saving to Company	Bonus to Men
Job #250	T. P	3839	.064	245.69	189.21	56.48	28.24	28.24
Totals								

Checked by J. M.

Fig. 6—Reverse Side of Card

in the straight piece-work system. On the other hand, there is not the same dependence upon the establishment of an absolutely correct price for the work.

The bonus system of the Interborough company is based on "list prices" which correspond to piece prices in the straight piece-work system. List prices are determined in much the same way as piece prices except that the refine-

ments used in determining the latter are not so necessary and are usually approximated or omitted. The list price, however, is made up with the aim of having it about 20 per cent higher than a straight piece price for the same work, the reason for this being that if the men produce work at a cost less than the list price the saving is equally divided between themselves and the company. If a man's output is in excess of the normal, as indicated by the list price, he gets paid for half of the extra pieces which he produces. Piece work pays him for all of them. Under piece work, for instance, a man who does twice the normal output gets twice the normal pay per week, but under the bonus system he would get only one and one-half times the normal weekly wage. If the list price of the bonus system is made 20 per cent more than the straight piece price, the doubled output gives only one and eight-tenths times the normal wage and the cost per piece is reduced 10 per cent.

In Fig. 5 and 6 are shown the two sides of a bonus system time card covering the work of a car-cleaning gang at one of the barns of the elevated railway. This daily cleaning of cars cost on the elevated railway in 1905 16.8 cents per car per day. In 1906 it cost 13.7 cents per car per day and in 1907 approximately 14 cents. The list price for cleaning a car as shown on the reverse side of the bonus time card has been set at 6.4 cents and the actual cost to the company is 5.6 cents per car per day. The men employed on the work, cleaning the same cars, are making exactly 30 per cent more than they were when working on an hourly rate.

In making up this card the time worked by the men and their ordinary day rates are entered in the usual manner for the whole week. The total number of hours worked multiplied by the day rate for each man gives the figures in the column headed "Amt. D. W." The total of this column is transferred to the similar column on the reverse side of the sheet, on which side are also entered the number of cars cleaned during the week and the standard list price for the job. Multiplying the number of cars cleaned, 3839, by the list price of 6.4 cents gives the figure of $245.69, which appears in the column headed "Am't at List." Subtracting from this the figure of $189.21 gives the total amount of $56.48 which appears in the column headed "List Minus Daywork" and which is divided equally between the company and the men. The amount of bonus, $28.24, is then divided by the total hours worked by all men during the week, or 1113, as shown on the face of the card, and then multiplied by the number of hours worked by each man during the week to give the amount of bonus for each man. These figures appear in the column headed "Amt. Bonus" on the face of the card. The total of this column should, of course, check against the same figure on the reverse side of the card, and the sum of each figure in the column and the corresponding figure under "Am't D. W." gives the weekly pay for each man. It is, of course, not necessary for the work covered by this card to be limited to one operation, and for that purpose space is provided on the reverse side of the card for different jobs and list prices. It is, however, desirable for all of the men in any gang to be kept together.

Table IV shows a number of "list" prices for work under the bonus system. These prices apply to the elevated and subway cars for which references in the Street Railway Journal have been given previously.

Table IV.—Bonus List Prices.

A. W. I. indicates "all work included."

Subway Cars.	FLOOR WORK.	
B-900	Strip, clean and assemble G. E. or Westinghouse motor after pinion has been removed, per motor A. W. I.	$1.00
B-901	Strip and make all necessary repairs and assemble truck, including the removal and replacement of wheels, motors, bolsters, brake rigging, etc., when necessary, and the overhauling and adjustment of brake rigging on motor and trailer trucks; also oiling and packing of armature bearings and motor axle boxes on motor trucks, per truck A. W. I.	3.00
B-800	Make all necessary repairs to motor shells, all types, per shell A. W. I.	2.00
B-801	Strip and make all necessary wiring repairs and rewire motor and trailer trucks, per car	1.00
	CAR CLEANING, ETC.	
B-1000	Clean windows on subway cars outside and inside, per car A. W. I.	$0.30
B-1001	Clean windows on subway cars, outside only, per car A. W. I.	.20
B-1002	Scrub seats and backs, per car A. W. I.	.25
B-1003	Sponge off seats and backs, per car A. W. I.	.13
B-1004	Dry wipe interior, including vestibules, per car A. W. I.	.13
B-1005	Clean markers, per car A. W. I.	.05
B-1006	Clean leather hand holds, per car A. W. I.	.05
B-1007	Clean sanitary hand holds, per car A. W. I.	.03
B-1008	Mop floor, per car A. W. I.	.16
B-1009	Renovate interior, including vestibules, per car A. W. I.	.40
B-1010	Scrub and renovate vestibules, center doors and barriers, per car A. W. I.	.40
B-1100	Car cleaning, sweep floors, dust and wipe interior of car, including lamps, and clean out under seats	.064
	CARPENTER SHOP.	
Elevated Railway Cars.		
B-4070	Manhattan or subway body sash (wood), remove glass, including beading and putty, per light A. W. I.	.04
B-4071	Same, glaze, per light A. W. I.	.08
B-4072	Manhattan or subway deck sash, remove glass, including beading and putty, per light A. W. I.	.014
B-4073	Same, glaze, per light A. W. I.	.026
B-4083	Manhattan car body and panels, 12¼ in. x 3 ft. 4 in.; plane, scrape and sandpaper by hand, each A. W. I.	.026
B-4084	Same, 14½ x 3 ft. 4 in.	.03
B-4085	Same, 16½ in. x 3 ft. 4 in.	.035
B-4086	Same, 18¼ in. x 3 ft. 4 in.	.038
B-4087	Same, 10 in. x 7 ft.	.045
B-4088	Same, 11 in. x 7 ft.	.048
B-4091	Center plate shims, ¼ in. up to ¾ in., make complete, each A. W. I.	.02
B-4092	Same, 1 in.	.03
B-4093	Same, 1¼ in. or 2 in.	.06
B-4127	Car body battens, long, plane, scrape and sandpaper by hand, each A. W. I.	.015
B-4128	Car body, battens, short, plane, scrape and sandpaper by hand, each A. W. I.	.008
B-4129	Car body window sill cornice board, plane, scrape and sandpaper by hand, per linear foot	.003
B-4130	Car body sash parting, plane, scrape and sandpaper by hand, each A. W. I.	.0075
B-4138	Car body sash partings, apply small patch to stop block, per patch A. W. I.	.03
B-4202	Manhattan window casing, plane, scrape and sandpaper by hand, each A. W. I.	.015
B-4276	Mahogany window capping, size ¼ in. x 2¾ in. or ½ in. x 4 in., plane, scrape and sandpaper by hand, per linear foot	.008
B-4284	O. G. molding, 2 in. to 3 in. width, plane, scrape and sandpaper by hand, per linear foot	.0028
B-4280	Window capping sash, 11 16 in. x 1¾ in., plane, scrape and sandpaper by hand, per linear foot	.0023
B-4330	Sash partings, mahogany, ash or oak, ½ in. x ¾ in. x 42½ in., set up, bore and countersink 10 holes, each A. W. I.	.006
B-4331	Same, plane, scrape and sandpaper by hand	.015
	MILL WORK.	
B-4238	Platform flooring, 1-in. yellow pine, 6, 8 or 10 ft. lengths, cross cut, each	.0035
B-4329	Cleats on car body for No. 1 motor, four wire, dress, rip, cross cut, join, layout, bore 47⁄64-in. holes and 5⅛-in. holes, mortise and re-saw, per pair A. W. I.	.12
B-4332	Side bearing shims, motor truck Manhattan, rip, cross-cut, join, lay out, bore two 7⁄8-in. holes and bandsaw, each A. W. I.	.01
B-4215	Rip to width 1-in. yellow pine, per linear ft.	.0005
B-4272	Floor strips, bore and countersink, per hole A. W. I.	.00085
	UPHOLSTERY SHOP.	
B-4303	Cushions, 19 x 19 Manhattan cars, strip and repair as follows: Remove rails, springs and canvas, repair springs and steels and apply lining and rail, making all necessary repairs, each A. W. I.	.30
B-4304	Same, 19 x 36.	.30
B-4307	Cushions, 19 x 19, Manhattan car, cover as follows: Cut and apply canvas, backing and cane, each A. W. I.	.24
B-4310	Cushion, 19 x 19, Manhattan cars, strip, repair and cover as follows: Cut and apply new canvas linings, remove and replace cane, each A. W. I.	.46
B-4311	Strip cane, 27 x 28 in., used in sewing, each A. W. I	.08
B-4312	Cushions, backs, side or cross, Manhattan or subway type, sew and apply canvas when necessary, each A. W. I.	.35
B-4314	Cross or longitudinal seat back, subway or Manhattan type, strip, make all necessary repairs and recover, each A. W. I.	.30
B-4315	Side cab or cross-seat cushions or longitudinal seat back, make all slight repairs and necessary sewing, each A. W. I.	.15

CONCLUSION

There is unquestionably no better method of reducing shop costs than that of applying some system of payment for work other than the customary hourly or day rate, and there is no worse procedure to follow than to count on low wages as a means for keeping down shop costs. Both the piece-work and bonus systems have passed the experimental stage for electric railway work. The prices which are published in this article have been obtained from J. S. Doyle, superintendent of car equipment, and T. M. Murphy, superintendent of piece work, Interborough Rapid Transit Company.

Shop Practices of the New Orleans Company

Some of the Methods Adopted at the Two Separate Shops at Which Standard and Wide Gage Cars Are Maintained —Output of the Foundry—Trail Car Operation—Accounting for Shop Work.

The New Orleans Railway & Light Company operates 589 passenger cars, of which sixty-six are trailers. The standard car of the New Orleans system has a 20-ft. body and two 5-ft. platforms, and is equipped either with two GE-80 motors or two Westinghouse 101 B motors. The motor cars include 175 double-truck cars, which have 34-ft. bodies and are 47 ft. over all. Sixteen of these cars have quadruple equipments with GE-58 motors. Each of the other double-truck cars is propelled by two GE-57 motors.

The rolling stock equipment is under the charge of the superintendent of equipment, who has as his chief assistants two master mechanics, one in charge of the Magazine shops, which maintain the 5½-ft. gage cars, and the other in charge of the Carrollton shops, which care for the standard-gage cars. In addition to the two car repair shops there are eight car stations at which some light repairs are made, such as the replacing of armatures and also the usual running repairs to trucks. Each carhouse is supplied with a storeroom and an ample supply of repair parts, so that usually the only time a car is taken to the main repair shops is when it is to be overhauled.

The work at all carhouses is under the supervision of an inspector of equipment, who is assisted by a foreman in charge of each carhouse. It is the practice for the carhouse foreman to meet with the superintendent of equipment at his office at 7 o'clock each morning and there discuss any special work for the day. At that time the carhouse foremen give the superintendent of equipment reports of all cars in the barns for repair work and make requisition on the storeroom for materials needed for these repairs. It is the practice to have as many cars as possible ready for service during the evening rush-hours each day.

FOUNDRY WORK

All the brass and bronze castings required for the entire system are manufactured at the foundry located at the Magazine shops. The output of this plant includes wheels, bearings, car fittings and hardware.

In the manufacture of trolley wheels six wheels are cast at one time. The mixture from which they are poured consists of 89 per cent copper, 1 per cent antimony and 10 per cent tin. Old commutator segments are used in the casting of trolley wheels. The service records of this company show that, considering all of the trolley wheels in use on the entire equipment of rolling stock, the average has a life of 7300 miles. The wheels as manufactured at this shop are fitted with ½-in. graphite bushings.

The bearings made in the foundry are cast from a plastic bronze mixture consisting of 10 per cent of lead, 1 per cent of tin and 89 per cent of copper. The journal brasses are finished on the axle sides by polishing with emery cloth fastened around a wood cylinder which revolves rapidly in a high-speed polishing lathe. This gives the bearings a smooth cylindrical-shaped inside surface. In the manufacture of bearings, trolley wheels and other small castings the foundry at the Magazine shops melts about 550 lb. of metal a month.

In the plating department of the Magazine shops a full equipment has been installed for nickel-plating all the car hardware and fittings of all rolling-stock equipment. Every time a car is shopped its hardware is buffed and polished, and, if necessary, replated also.

The New Orleans company has standardized on the gears and pinions manufactured by the Tool Steel Gear & Pinion Company of Cincinnati. It has obtained as high as 110,000 miles from one of these pinions.

All the motor cars of the New Orleans system are equipped with automotoneers, and the excellent results obtained with this device are illustrated by the statement that formerly six armature winders were required, while now the armature work for the same number of cars is handled by two winders and one helper.

In babbitting the armature bearings for the GE-57 motors the bearing halves are centered with yedges about the armature shaft after a piece of paper has been wrapped around it. The oil hole is filled with a plug and the babbitt is poured in the end of the shell. By following this method of babbitting it is unnecessary to rebore the bearings; and an increased life is obtained from the bearings because the hard skin forming over the outside of the babbitt is not cut away before the bearing is put into service.

In refitting old resistances the frames are used and the ribbon resistance is replaced by special grids. This practice saves the cost of new frames.

BRAKESHOES, JOURNALS, ETC.

The brakeshoe equipment of all the cars of this road has been standardized during the last two years, and as a result the amount of metal worn away has been reduced greatly. The brakeshoes are manufactured by the American Brake Shoe & Foundry Company. Those used on the large double-truck cars are of the Streeter type with steel inserts, and those on the single-truck cars are of the Herron type.

At each of the carhouses a journal box waste-soaking and draining tank has been installed in order to save lubricating oil. The tanks are made of galvanized sheet steel and are fitted with tight covers. Each tank is provided with a draining basket into which the supply of oil-soaked waste for immediate use is placed until the excess oil has been drained out. A supply of waste sufficient to last a week is stored in the bottom of the tank under the oil and allowed to remain there at least forty-eight hours.

The vestibules of all single-truck cars are being extended so that the dash will be flush with the edge of the bumper. This change adds 8 in. to the length of each platform, making it 5 ft. 8 in. from the end sill of the car to the dash iron. In addition to the advantage of increased platform space thus gained, no foothold remains outside the dash on which trespassers may ride, while the bumper and platform sills are fully protected from water.

On all the later designs of cars used in New Orleans Perry automatic ventilators are installed. These ventilators, which are of the exhaust type, fit into a deck sash opening.

COMMUTATOR PRACTICE

All new commutators are slotted to a depth of from ¼ in. to ⅝ in. and the slots are then filled with plaster of paris mixed with shellac. Before the application of this mixture the copper of the commutator is heated with a gasoline blow torch. The mixture is smeared on with a putty knife and allowed to cool. It is stated that this practice, while avoiding too frequent reslotting of the motor, keeps the carbon dust from packing between the bars, thus saving the possibility of short circuits.

The work of slotting commutators is done on the tool shown in the accompanying illustration. This slotter was designed by William Dickenson, master mechanic of the Carrollton shops. It is simple in construction and yet will work on any size or type of railway motor commutator such as would be used by city or interurban roads. It is operated by a flexible shaft driven by a belt or by an individual motor. Twenty bars can be slotted without turning the armature and no wrench is necessary for setting the slotter or making the adjustment.

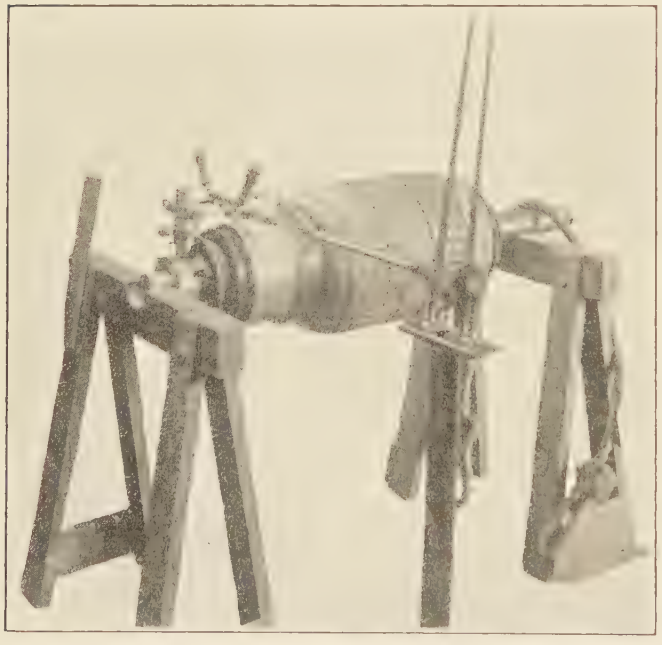
TRAILER CAR OPERATION

During the rush hours at night and morning the New Orleans system attaches single-truck trailer cars to a number of its single-truck motor cars. The two units in the train weigh 19,000 lb. and 13,500 lb. respectively. The motor cars are equipped with two GE-80 motors and they handle the trailers successfully in the regular rush-hour city service. During the middle of the day, when trailers are not hauled, the braking is done with the hand brake equipment, but during the rush-hour the air brake equipment is used. In order to economize on the weight of the motor cars so that they might be more efficient for midday operation, the motor compressor and tank for the air brakes are installed on the trailer cars. The two cars are connected by two lines of hose and a light jumper which is of sufficient capacity to carry energy to the air brake motor compressor.

SHOP ACCOUNTING AND RECORD FORMS

Some of the blank forms used in accounting for the operations of the shop and power-house work are of particular interest. The daily time sheet, reproduced herewith, is used by all shop and carhouse employees for turning in their time and noting a description of the work each day. The helpers simply note on their time sheet the name of the man whom they assisted and the distribution on that man's daily time sheet will cover the work of both men. There are about 350 men in the mechanical department. The time sheets are turned in to the office of the superintendent of equipment, and there the time is distributed on an individual time sheet. The latter sheets, 21 in. x 10½ in., are arranged for loose-leaf binding and are printed on both sides. One page represents the complete distribution of the time of one man for one month and his labor is distributed according to the account numbers. Thus the molder for the daily individual time sheets has 350 sheets for each month and there are twelve books for each year. After the accounts have been transferred the books are filed for reference.

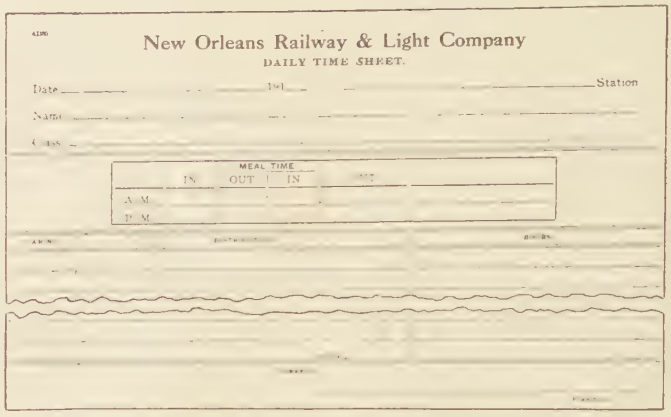
An individual material sheet, designed according to the same scheme as the individual time sheet, is kept for each carhouse. The original sheets are arranged for insertion in a loose-leaf folder and are 21 in. x 14 in. in size, printed on both sides.



New Orleans—Commutator Slotter

A daily mileage sheet is furnished by the transportation department for the equipment department each day for the cars operated out of each carhouse. The mileage sheets are punched for loose-leaf binding and are 8½ in. x 14 in. in size.

The records of car mileage of the various parts of the electrical equipment are entered on the pages of a mileage book, which is 15½ in. x 21 in. in size and has a page numbered for each car on the system. The cumulative mileage is entered each day so that by comparison of the mileage on the date at which any part of the equipment was installed and the mileage on the date when it was removed, the total mileage run may be obtained.


New Orleans Railway & Light Company
DAILY TIME SHEET.
Date
Station
MEAL TIME
IN
OUT
IN
A. M.
P. M.

New Orleans—Daily Time Sheet

The office of the superintendent of equipment furnishes the repair foreman at every carhouse a weekly statement of the armature mileage for each car under his charge, enabling him to observe easily the exact results of any changes made in the design or any changes in the method of maintenance of car parts.

The repair foremen make up monthly car wheel service reports, showing the serial number, the dates at which wheels were put in and taken out of equipment, the mileage made and the location of the wheels under the car.

Repair foremen make daily reports to the superintendent of equipment on a blank 7¾ in. x 13¾ in. in size. This shows opposite the car numbers the repairs made, materials used, time of labor and the cause of the repairs. It also shows at the bottom opposite the car numbers the reasons why any cars were withdrawn from the service on account of defects. The defect reports are summarized each month on a blank 23 in. x 14 in. in size, arranged for binding in a loose-leaf folder. The entries show the defective cars on each line for the entire system, the totals by division, the causes for the defects on each line, the average number of cars operated daily and the percentage of crippled cars.

A special form is used for the monthly consolidated summary of the accounts devoted to the equipment department.

The New Orleans Railway & Light Company is planning the construction of large new shops. This company is now managed by Huge McClosky, president. D. A. Hegarty, formerly of Little Rock, Ark., is manager of the railway, operating and commercial electric departments. H. J. Dressel is superintendent of transportation and R. M. O'Brien is superintendent of equipment.

The Quebec Railway, Light & Power Company operates an amusement park at the Falls of Montmorency, 9 miles from Quebec. The devices are mainly a merry-go-round in summer and slides in winter, but the company has decided not to enlarge the amusement features there, on account of its distance from the city. The company, however, may later on undertake to create an amusement resort at some more convenient location. A company was organized last year to start an amusement park along American lines, but the managers say they have not gone beyond its organization and are not likely to go further for a year or so. The two chief amusement resorts at Montreal are operated by the Dominion Park and Luna Park companies.

TRIP OF THE AMERICAN ELECTRIC RAILWAY ASSOCIATION EXECUTIVE OFFICIALS

Further details of the plans for the trip of the executive officials of the American Electric Railway Association have been completed. The itinerary is shown in the table published herewith.

In making the itinerary public, the officials of the association emphasize the fact that their time of arrival in various cities is shown merely as a guide, and that it is not expected that members will meet the party when the time of arrival is at an inconvenient hour. In many of the places reached the party will meet representatives of civic bodies and the public officials. This will afford an opportunity for expression of the point of view of the association regarding the problems that affect the industry. The trip also affords an opportunity for more intimate acquaintance of the officials of the association with the representatives of the various companies and the properties which they manage.

Itinerary for the Trip of Executive Officials of the American Electric Railway Association.

Car "Advance," Leaving New York, Pennsylvania Railroad, April 17, 1912, 9:30 p.m.

Date.	City.	Hour of Arrival.	Railroad.	Hour of Departure.	Railroad.
April 18	Richmond	7:50 a.m.	W. S. & R. F. & P.	7:35 p.m.	Atlantic Coast Line.
April 19	Charleston	6:57 a.m.	Atlantic Coast Line	11:00 p.m.	Southern.
April 20	Augusta	6:55 a.m.	Southern	....	
April 21	Augusta	....		11:15 p.m.	Central of Georgia.
April 22	Atlanta	6:25 a.m.	Central of Georgia	8:50 p.m.	Nashville, Chattanooga & St. Louis.
April 23	Nashville	6:35 a.m.	Nashville, Chattanooga & St. Louis	11:30 p.m.	Nashville, Chattanooga & St. Louis.
April 24	Memphis	7:45 a.m.	Louisville & Nashville	9:00 p.m.	St. Louis & San Francisco.
April 25	Birmingham	6:15 a.m.	St. Louis & San Francisco	....	
April 26	Birmingham	....		4:05 a.m.	Louisville & Nashville.
April 26	Mobile	1:15 p.m.	Louisville & Nashville	....	
April 27	Mobile	....		3:38 a.m.	Louisville & Nashville.
April 27	New Orleans	7:50 a.m.	Louisville & Nashville	....	
April 28	New Orleans	....		10:00 p.m.	Morgan's Louisiana & Texas.
April 29	Galveston	12:20 p.m.	Galveston, Harrisburg & San Antonio	4:45 p.m.	Galveston, Harrisburg & San Antonio.
April 30	Dallas	7:30 a.m.	Houston & Texas Central	6:30 p.m.	Texas & Pacific.
May 1	Oklahoma City	4:16 a.m.	Atchison, Topeka & Santa Fé	7:20 p.m.	Atchison, Topeka & Santa Fé.
May 3	Grand Canyon	4:00 p.m.	Grand Canyon	....	
May 5	Grand Canyon	....		8:10 a.m.	Grand Canyon.
May 6	Los Angeles	7:10 a.m.	Atchison, Topeka & Santa Fé	....	
May 8	Los Angeles	....		8:00 a.m.	Southern Pacific.
May 8	Santa Barbara	11:10 a.m.	Southern Pacific	8:50 p.m.	Southern Pacific.
May 9	San Francisco	9:15 a.m.	Southern Pacific	....	
May 12	San Francisco	....		8:20 p.m.	Southern Pacific.
May 14	Portland	7:30 a.m.	Southern Pacific	....	
May 15	Portland	....		12:15 a.m.	Great Northern.
May 15	Vancouver	3:30 p.m.	Great Northern	....	
May 16	Vancouver	....		12:15 a.m.	Great Northern.
May 16	Seattle	8:10 a.m.	Great Northern	....	
May 17	Seattle	....		7:30 p.m.	Northern Pacific.
May 18	Spokane	10:10 a.m.	Northern Pacific	10:15 p.m.	Northern Pacific.
May 20	Fargo	3:35 p.m.	Northern Pacific	10:50 p.m.	Northern Pacific.
May 21	Minneapolis	7:10 a.m.	Northern Pacific	....	
May 21	St. Paul	....		8:05 p.m.	Chicago & Northwestern.
May 22	Omaha	7:30 a.m.	Chicago & Northwestern	4:35 p.m.	Chicago, Burlington & Quincy.
May 23	St. Louis	7:19 a.m.	Chicago, Burlington & Quincy	10:10 p.m.	Southern.
May 24	Louisville	7:10 a.m.	Southern	11:00 p.m.	Pennsylvania.
May 25	Indianapolis	1:50 a.m.	Pennsylvania	....	
May 26	Trip over Illinois Traction System.				
May 27	Indianapolis	....		4:32 a.m.	Baltimore & Ohio Southwestern
May 27	Cincinnati	7:50 a.m.	Baltimore & Ohio Southwestern	9:00 p.m.	Pennsylvania.
May 28	Pittsburgh	6:15 a.m.	Pennsylvania	9:40 p.m.	Pennsylvania.
May 29	New York	8:08 a.m.	Pennsylvania.		

W. L. Conwell, president of the American Electric Railway Manufacturers' Association, in making an announcement to the members regarding the trip, says in part:

"The greatest problem confronting the railroads to-day is antagonistic public feeling, and this attitude of the public must be changed if the industry is to rest upon a sound financial and commercial foundation.

"It is, therefore, our duty as an association and as individuals to assist in every way possible to bring about a better understanding of the problems which seem to be responsible for present undesirable conditions, and much can and will be accomplished if each of our member companies and their representatives will assist in bringing together at the cities named in the itinerary those directly interested in electric railways and others not directly interested, but whom because of their standing in the communities visited it is desirable we should meet. Already arrangements for meetings of this character with railway representatives, public officials and civic organizations are well under way, and, as a suggestion, it might be a good idea for each of our companies through its proper representative to get into touch with the railway officials in the cities named and the surrounding territory and proffer such assistance as may be desired in the development of necessary arrangements.

"Through such meetings both associations will have splendid opportunities to increase their membership and broaden the scope of their influence, but to bring about the desired results will require vigorous action on the part of the entire membership, and this I am satisfied will be freely given when the objects and possible benefits to be derived from the success of this plan are fully understood."

CONVENTION BULLETIN NO. 2

Convention Bulletin No. 2 has been issued by Secretary H. C. Donecker, of the American Electric Railway Association. This gives information with reference to the hotels in Chicago and the accommodations that will be available for the annual convention to be held in that city from Oct. 7 to 11.

The circular also gives information in reference to the meeting and exhibit halls. The Dexter Pavilion, Forty-third and Halsted Streets, where the exhibits will be located, has direct connection with the tracks of the Chicago Junction Railroad. Full details as to the layout and space available will be furnished at a later date. Further details regarding the transportation facilities between hotels and the convention halls will be furnished later.

Secretary Donecker says that the association has received many letters indorsing the decision of the committee in the selection of Chicago as the convention city, and that all express the belief that the 1912 meeting will far exceed in attendance that of any previous year. The following hotels have been selected as convention headquarters of the various associations:

American Association	Congress
Accountants' Association	Congress
Engineering Association	Auditorium
Claim Agents' Association	Stratford
Transportation & Traffic Association	Blackstone
Manufacturers' Association	Congress

In closing, the circular urges delegates to make requests for rooms promptly, stating that ample accommodation is available now.

A FEW THOUGHTS ON PUBLICITY

BY JOHN A. BEELER, GENERAL MANAGER DENVER CITY TRAMWAY COMPANY

Publicity of the right kind, at the right time and in the proper place often accomplishes much good. Publicity, to be genuinely effective, must always be truthful, and this often involves caution, if not diplomacy.

There are many instances where it is extremely difficult to handle publicity properly. For instance, with the questions of values, which are often under consideration, there are the physical, the franchise and the earning values. To prepare a statement that will be acceptable alike to bondholders, shareholders, the traveling public and the public authorities means a work of art.

This is one reason why many companies shrink from any suggestion of publicity and withhold all information regarding their operations. The local public, reading of immense transactions, high financing and stock jobbing on a large scale on some large metropolitan system where millions are alleged to have been "cleaned up," immediately concludes that the local concern is a bonanza of the "get-rich-quick" variety, and that either its taxes should be raised or its rates reduced, or both. It is only too true that some of the most lucrative properties, surrounded by exceptionally favorable conditions, have been conducted in such a flagrant manner that the most ably managed and conservative concerns in less favored communities are greatly handicapped.

Publicity may help, but I believe that it alone is not sufficient. In connection with it some plan must be perfected that will interest the general public. Something more is required than the general statement that the company is operating "on a very small margin." It is an undeniable fact that there is a general tendency to condemn all corporations throughout the United States. Some one has been heard to remark lately that there are "good and bad corporations." All corporations are in the latter class except those in which we personally are interested. This may not be literally so from an individual standpoint, but from the public's standpoint, collectively, it is true.

Any amount of publicity will not overcome this anti-corporation feeling. The remedy must be deeper. It must reach down and take hold of the self-interest of the individual. Then a little publicity may accomplish a great deal. Then we may transform "knockers" into "boosters."

I believe the time is at hand when we must endeavor to market our securities, as far as possible, locally, and not in large blocks but in small lots. If this is done in a city of 100,000 people, with 10,000 or 5000 or even 1000 of them interested in a company's securities, it will have friends on every side to help in ways too numerous to mention. In a city of 100,000, with, say, 5000 holders of securities averaging $200 each, this is a total investment equaling $1,000,000, perhaps but 20 per cent of the total capital of the company. But I will venture the assertion that this 20 per cent of small holdings, sprinkled thoroughly among the citizens, will leaven the whole body and be of more real benefit to the company than the 80 per cent held otherwise. As far as I can see, there is no reason why the same plan will not work beneficially in larger and in smaller communities.

What company is there that could not afford to have 20 per cent or even 50 per cent of its shares or bonds thus held by local citizens? Each small investor should be afforded a special opportunity to get in. No gold bricks should be offered him. His interest should be safeguarded more strongly, if possible, than that of the largest investor.

Small denomination savings bonds, $50 each (or smaller, if necessary), interest 5 per cent, yearly coupons attached, could be sold, and the security behind these bonds would be the property itself, or a deposit of the company's first mortgage bonds as collateral, in quantity sufficiently in excess of the face of these savings bonds to make them "gilt-edge." After having made them absolutely safe, a little flavor of speculation might be added to stimulate interest and help to increase their value by a method of calling by lot annually 5 per cent or 10 per cent of the outstanding bonds and of paying them off at a premium of 5 per cent. It might be desirable to make provision for the sale of these securities on instalments, and a medium of sale and exchange should also be provided in order to make a ready market and maintain the true value of the security.

Several things are likely to be accomplished after carrying out such a program. By encouraging the habits of saving and thrift the general prosperity of the locality is increased. "Spenders" are transformed into "investors," the general public increases its friendship and the company strengthens its hold on the community. The public then reads the statements with real interest.

While these ideas may not apply to all communities or to all companies, I believe that some such general plan, with slight modification, will work under most conditions. It is a fact that in most communities there is no really safe and attractive investment for the individual with less than $100. The only alternatives are a savings bank or a "get-rich-quick" scheme. There is a general prejudice against savings banks, and nine times out of ten the "get-rich-quick" scheme is selected, with the inevitable result of loss.

In France small bonds are common, and everybody seems to have acquired the habit of accumulating them. This policy has made France more powerful than some of its more warlike neighbors and one of the richest and most prosperous nations in the world. Therefore, I think the time is at hand when we should follow the example of the people in the French Republic in the matter of issuing small bonds. They must always be safe, then attractive. Every holder then becomes a publicity agent of the right kind and one who works night and day without cost to the company and knows of no closed season.

MEETING OF COMMITTEE ON SCHEDULES AND TIMETABLES

The committee on schedules and timetables, American Electric Railway Transportation & Traffic Association, met at the Claypool Hotel, Indianapolis April 4. Those present were W. R. W. Griffin, Tri-State Railway & Electric Company; T. F. Grover, Terre Haute, Indianapolis & Eastern Traction Company, and C. E. Morgan, Michigan United Railways. The method of preparing the report was the principal subject for discussion. The work will be subdivided among the committee members as follows: Mr. Grover, rules for misses; Mr. Morgan, carhouse records; Messrs. Wood, Long Island City, N. Y., and Lee, Cincinnati, Ohio, records showing seniority and working lists; Messrs. Schindler San Francisco, Cal., and Hewitt, East St. Louis, Ill., keeping trainmen's time, and John E. Duffy, Syracuse, N. Y., meal reliefs. The chairman in making assignments will instruct members to analyze their sections of the answers to the data sheets and to suggest recommendations for the action of the committee as a whole. One hundred and fifty replies have been received to the data sheet sent to member companies.

A surprising reduction in the size and number of clinkers formed in a steam boiler furnace may be effected by the admission of a small amount of live steam or even exhaust steam into the ash pit. It is largely due to this fact that the steam jet system of forced draft has achieved its popularity for use with low-grade fuels. These generally contain enough iron pyrites or other metallic binder to cement a considerable portion of the ash into large and obstinate clinkers.

Meeting of the Central Electric Railway Association

Papers on Maintenance of Electric Railway Equipments and Methods of Fire Prevention Presented at the Indianapolis Gathering—Discussion on the Report of the Standardization Committee and Protection Against Lightning

A regular meeting of the Central Electric Railway Association was held at Indianapolis, Ind., on April 4 with President Whitney in the chair. About eighty delegates were present. Five new members were elected.

COMMITTEE REPORTS

The first order of business was the presentation of committee reports. Guy K. Jeffries, Terre Haute, Indianapolis & Eastern Traction Company, reported progress by the committee on methods for cutting out high-tension lines. Upon his recommendation, more time was given to the committee to formulate a report. H. H. Buckman offered the report of the standardization committee, which presented seven recommendations for committee procedure relative to the consideration and adoption of standards to be worked out in conjunction with the American Railway Engineering Association. The report suggested that after the Central Electric Railway Association had approved the standards offered they be referred to H. C. Donecker for the attention of the American Electric Railway Association, of which Mr. Donecker is secretary. This report recommended joint working arrangements with standardization committees of the American associations. More time was requested to consider standards for destination signs, conductors' train signal system and standard trolley wheels. The report of the standardization committee was approved.

Mr. Buckman requested and received permission to change earlier recommendation regarding anti-climbers so that their use would be approved practice rather than recommended practice; also that the 8-in. section would have corrugations 2½-in. deep. Charles L. Henry, Indianapolis & Cincinnati Traction Company, suggested further study of the design of and actual experiences with anti-climbers under different conditions.

Mr. Buckman said that his committee felt greatly encouraged over the co-operation received from the standardization committee of the American Electric Railway Engineering Association. He had been requested to send a representative to the Pittsburgh meeting of the equipment committee of that association. He had appointed L. M. Clark, Terre Haute, Indianapolis & Eastern Traction Company, to attend that meeting.

LIGHTNING PROTECTION

The paper on lightning protection read at the Louisville meeting by E. J. Burdick, Detroit United Railway, was the next subject for discussion. This paper was published in the Electric Railway Journal for Nov. 25, 1911.

Edward Heydon, Indianapolis Traction & Terminal Company, approved Mr. Burdick's recommendations. He then discussed the Nichols arcing ring for protecting high-tension insulators, as used on the Niagara Falls-Syracuse transmission line. These rings relieved stresses and reduced punctures.

J. E. Cochrane, Lima, superintendent overhead line Ohio Electric Railway, described two forms of transmission line construction erected in the same territory on which very different results from lightning storms were observed. One type had an 8-ft. top arm with two wires on one side of the pole and one wire on a 5-ft. arm below the three wires, making a delta 30 in. on a side. With this wire arrangement, 90 per cent of the lightning bolts damaged poles at the trolley feeder cross-arm 8 ft. below the bottom high-tension arm, while lightning split the top of the poles eight times out of ten on those lines which had 10-ft. cross-arms carrying all of the transmission lines in a single plane.

C. N. Wilcoxon, Chicago, Lake Shore & South Bend Railway, said he had not lost an insulator last year on his 72-mile road and that he had had practically no lightning troubles. He credited these good results to the use of six fused horn gap arresters per mile and three electroytic arresters in power stations; also to the use of an overhead ground wire of ⅞-in. strand galvanized wire placed 4 ft. above the transmission wires and grounded at every fourth pole.

C. E. Morgan, Michigan United Railway, said that the Indianapolis, Crawfordsville & Western Traction Company had greatly reduced lightning trouble on its high-tension lines by replacing open choke coils with oil-insulated choke coils. It was now placing the same coils on the regular low-tension trolley circuits.

Mr. Henry said that he had 21 miles of cross-country transmission line which gave much trouble, although partly protected by overhead ground wire, until he had put on larger insulators. Consequently he had most faith in generous insulation.

FIRE PROTECTION

F. R. Daniels, inspecting engineer Indiana Fire Insurance Bureau, then read a paper on "Fire Hazards and Methods of Prevention." An abstract of this paper is printed elsewhere in this issue.

R. C. Iddings, Pyrene Manufacturing Company, presented practical examples of the use of his company's fire extinguisher. Mr. Daniels said that while pyrene was an excellent fire extinguisher it might be found too small to put out large fires in the roof. This type of extinguisher was described in the Electric Railway Journal for Jan. 13, 1912.

Mr. Henry emphasized Mr. Daniels' point that the reduction of fire hazards does not receive sufficient attention.

In the further discussion on the elimination of fire hazards, E. F. Schneider, Cleveland, Southwestern & Columbus Railway, recommended that fire extinguishers should be carried at the rear end of the cars.

Mr. Daniels suggested the replacement of the 3-gal. extinguisher in fireproof substations and power houses by buckets of sand and by a pyrene or similar extinguisher which would not damage electrical equipment.

MAINTENANCE OF EQUIPMENT

The next order of business was a paper by J. L. Crouse, engineering department Westinghouse Electric & Manufacturing Company, on "The Maintenance of Electric Railway Equipment." This paper is printed elsewhere in this issue. In conclusion, Mr. Crouse recommended that articles on maintenance, such as were found in the Electric Railway Journal, should be sent to the different shop foremen for their comments.

R. N. Hemming, Indiana Union Traction Company, asked Mr. Crouse if spraying armatures did not result in filling the ventilating ducts with varnish. Mr. Crouse replied that trouble would not be experienced if a very light varnish was used.

MISCELLANEOUS BUSINESS

Just before the meeting adjourned, Mr. Henry brought up the question of block signals. He announced that he was installing 18 miles of the new Simmen type of signals and invited all the members to visit his line to investigate them in operation about May 1.

The next meeting of the association will be held at Cedar Point, Ohio, June 12, 13 and 14.

FIRE HAZARDS AND METHODS OF PREVENTION

BY FRANK R. DANIELS, ENGINEER INDIANA INSPECTION BUREAU

The basic element of fire prevention is "shop management" or "good housekeeping," in furtherance of which the following general suggestions might be offered:

(a) Floor sweepings, greasy papers, oily waste, paint rags and like materials subject to easy ignition should be kept in standard metal waste cans and their contents burned every night.

(b) Ashes should be kept in metal receptacles and removed daily, care being taken not to deposit them near combustible material or to drop hot coals on wood floors. The ashes from car stoves should be emptied while the cars are on the road.

(c) Workmen's clothing should be kept in metal lockers and discarded clothing should be burned.

(d) Oily metal turnings or filings should not be permitted to accumulate upon wood floors or in combustible receptacles, nor allowed to be mixed with sawdust or other combustible material.

(e) Car cleaning should be done in the open or in a specially designated section. Vacuum-cleaning systems promote cleanly conditions and are also economical.

(f) Grease should not be allowed to collect in pits or on tracks. Fine sand should be used to absorb it instead of sawdust.

(g) Wood turnings, shavings and sawdust should be cleaned up and removed daily, automatic methods being desirable for large shops. Fine particles of sawdust should not be allowed to collect, as they become explosive under certain temperatures.

(h) Paints and oils should be stored in a detached oil house, and not more than one day's supply should be kept in the buildings where they are used. Volatile oils should be taken from standard safety cans. Lanterns should be filled and trimmed by daylight on a metal filling table in the oil house. Journal waste should be kept in metal tanks and the journal boxes packed outside of the shop wherever such practices are possible.

(i) Heating systems should be preferably of the low-pressure steam or hot-water circulating types, with boilers in a detached building. Steam pipes should not touch wood.

(j) Portable lights should have proper safeguards.

(k) All specially hazardous and dangerous processes or devices should be in separate fire divisions and should be protected by suitable fire-extinguishing devices.

(l) Rules should be enforced whereby the foremen are held strictly responsible for the maintenance of good conditions, and a written report should be filed with some official at stipulated intervals.

FIRE RISKS OF VARIOUS KINDS OF CONSTRUCTION

With "fireproof" construction the fire damage to the building is not considerable, if any. The higher first cost is justified by the unlimited life and very small depreciation, the latter amounting to approximately one-tenth of 1 per cent per annum.

Mill or slow-burning construction has many desirable features such as smooth surfaces presenting less combustible area, comparatively slow spread of the fire due to the heavy timbers and the self-releasing feature of the burned section, which prevents the collapse of the entire structure. The greater cost of this construction compared with the ordinary light joist type is justified by its longer life and small cost of upkeep. However, it requires more protection than the fireproof type.

Ordinary construction may be said to include light joist construction, in which large areas of combustible material are exposed to the rapid spread of flames, and also the various types of wood construction carried upon unprotected metal trusses.

RISKS PECULIAR TO ELECTRIC RAILWAY STRUCTURES

In railway buildings there are many features which add to the fire risk. Thus the pits should not have a greater area than is necessary for efficient operation nor be continuous under more than four tracks; furthermore, they should be of non-combustible construction. The spacing of tracks is important because sufficient space must be provided to make fire protective apparatus accessible, while to permit quick removal of cars straight tracks free from frogs, switches or transfer tables and easy outside curves provided with guard rails are imperative. If the track spacing is too close, streams of water cannot be directed upon the base of fire. The rail joints should be well bonded and the trolley wires carefully supported. Lightning protection and means for cutting all wires out of circuit in case of fire should also be provided. Trolley poles on stored cars should be disconnected from wires.

FIRE RISK FROM CARS

In spite of the foregoing railway risks, there is none more worthy of consideration, although often neglected, than the car. The greatest two sources of car fires are the electrical equipment and the heating. Cars are subjected to all sorts of weather and, as a rule, are run by men who are neither electricians nor mechanics. Should any of the apparatus give trouble, it is a case of running along until something gives way under the abnormal strain. Again, service cars are often housed without undergoing an inspection which would reveal conditions which might start a fire.

As to the fire hazard from heaters, electric heaters properly installed may be considered safest. Increasing in the order of hazard are hot-air, hot-water and coal stoves. The hazards of coal stoves are carelessness in ash handling, such as dropping hot coals on floors of cars and buildings, poor insulation of smoke vents at the roofs, open drafts causing overheating and the insecure fastening of the stove to the car body. Extinguishers upon cars are of vital importance, as fires often occur on the road. It would be better if two extinguishers were carried instead of one. They should be accessible, but be placed where they are liable to the least injury.

POWER HOUSES AND SUBSTATIONS

The only serious electrical hazard in power houses and substations is the oil-cooled transformer. Should there be a breakdown in the insulation between the windings, the ignited oil may generate enough heat to weaken unprotected metal supports in the roof and may communicate flame to any combustible material. The only other prominent hazard is spontaneous ignition, which is found where much bituminous coal is stored. This hazard may be greatly reduced by storing the coal in many separate fire sections.

GENERAL

Interior protection may be defined as means for fighting fires in their incipiency. These means include sand pails, water pails, chemical extinguishers, small hose and automatic sprinklers. Omitting the automatic sprinklers, which have been developed in recent years and have proved their worth and reliability, we have the pail of water as heading the effective list of extinguishing agents. Next are chemical extinguishers, by means of which a small stream of water may be directed at the base of a fire or to corners and recesses which could not be reached with a bucket. Extinguishers require constant care, but are easily operated. Certain extinguishers depend for their effectiveness upon the confinement of carbonic acid gas at the base of the flames. This type is best chiefly for oil and electric fires, but not for fires where the gases cannot be confined. The small hose is for supplementary use where the hand devices fail, or for confining the flames in large fires until the fire department arrives.

The last type of protection is the public water works and fire department. Do not stop to fight the fire with the

available apparatus, but notify the department first and then do what else you can. Have an alarm box close at hand, thus saving time and avoiding the liability of error in transmission by some excitable individual at the telephone.

No definite practices can be laid down for outside fire protection with hydrants and mains, since this depends entirely upon the location, construction and use of the buildings. As the essential feature of the immediate discovery of fires during the hours of non-operation is dependent upon the watchman some reliable form of recording apparatus should be used to check his vigilance.

THE MAINTENANCE OF ELECTRIC RAILWAY EQUIPMENTS

BY J. L. CROUSE, RAILWAY ENGINEERING DEPARTMENT WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY

Successful maintenance of railway equipment means the greatest reliability in service combined with the greatest economy. Ten years ago it was the practice on many electric railways to have one or more electricians whose duty was to be on hand at all times to make hurried repairs to cars which broke down in service. In a word, repairs were made only when necessary and after the trouble had occurred. The present-day practice is to inspect all apparatus at regular stated intervals in order to prevent trouble as far as possible.

While the reduction of maintenance costs has been a very live topic during the past several years, nevertheless it may safely be stated that many of the small city and interurban railways to-day are wasting thousands of dollars annually through their apparent inability to depart from the old-fashioned method of waiting until trouble occurs before giving attention to the equipment.

The principal duties of the writer during the past six or eight years have been to investigate causes of delays in service and also maintenance costs; to make recommendations for the correction of the former and provide ways and means for the reduction of the latter. During this period many railway repair shops have been visited and, to be candid, the writer has frequently wondered how some companies get along as well as they do with the equipments in the condition in which they were found. On the other hand, there are many roads where the equipments are well maintained, and the cost sheets at the end of the month as a rule bear out this fact.

There is seldom an opportunity to compare the maintenance costs on one road consistently with those on another. This is due to the fact that a great number of things determine the cost of upkeep. Among these are line voltage, weights of cars, schedule speeds, stops per mile, gear ratios, capacity of the equipments, air brakes, condition of the track, type of motors or control, training of the motormen, wear allowed on axle bearings before removal, wear allowed on armature bearings before removal, wear allowed on gears before removal, the opportunity for and facilities provided for inspection and repairs, etc.

Some railroads house, inspect and make all repairs at one place and have sufficient spare cars so that regular periodic inspections may be made; others with similar mileage and similar equipment are obliged to lay up cars at various points and operate much dead mileage in order to make periodic inspection or repairs, resulting in spasmodic attempts instead of continued, studied efforts to keep every detail in good condition.

MAKESHIFT REPAIRS

The average makeshift repair job, while made for economical reasons as a rule, proves to be very expensive in the end. For example, an old armature is repaired by putting in one or two new coils or splicing out a damaged coil, the idea being that it is cheaper to do this than to rewind the armature. In most cases the entire set of new coils would cost approximately $35, but when completely rewound the armature would be good for at least a couple of years' steady service, while the makeshift repairs usually result in another breakdown in a month or so. The cost of bringing in the car and opening up the motors, plus the loss of traffic and time the equipment is out of service, etc., will usually be nearly double the cost of a new set of coils.

Numerous instances have also been seen where cars were brought in and repairs made on one motor and the remaining motors and equipment on the car were not even examined because they had not been reported as defective. As the big portion of expense is caused by bringing the car in for repairs, all the equipment should be put in good shape before the car is sent out again. Where makeshift repairs are the practice the records usually show something like this:

July 1—Car No. 242 in shop, grounded armature, of No. 1 motor.
July 3—Car No. 242 in shop brake trouble.
July 4—Car No. 242 in shop, grounded brush-holder, of No. 2 motor.
July 7—Car No. 242 in shop, controller trouble.

Such records betray lack of thorough inspection when the car was first brought into the shop for repairs. To correct this, the manager or superintendent should insist on reports that will show that, although the car was in the shop a few days previously, this recent defect was not discovered, and he should take sufficient interest on each occasion to ask why. This policy will convey to the minds of the shopmen that their superior is watching these details, and thus will make them more thorough in their work.

In all cases where cars are taken out of service to be repaired a special report should be made to the manager, showing the cause of trouble and date and the name of the inspector who made the previous regular inspections. The foreman should be required to state in this report whether the trouble could have been prevented if the car had been properly inspected or whether it was unavoidable.

CONDITION OF SHOPS

In visiting various shops the condition of the equipment could frequently be foretold by an inspection of the shop, storeroom and scrap pile. Often motor and control parts were found strewn over the floor; little or no material was found in the storeroom, as supplies were used up as fast as received, or cars were laid up waiting for them. Large scrap piles contained cast iron and steel mixed together; also, brass and copper were found in the same bins or frequently piled out in the yard. Parts were found that might have been repaired by the men at odd times by removing the worn parts such as brush holders, springs and hammers, control fingers, etc. A great saving can be made by sorting the materials properly and not allowing them to accumulate for too great a length of time.

Where the foregoing conditions were noticed it followed that no system of records was kept. On the other hand, a clean shop usually would have a well-kept storeroom, a small scrap pile and equipment in good condition, with a master mechanic or foreman who was prepared to give any desired data from his well-kept record.

INSPECTION AND GENERAL OVERHAULING

The frequency of inspection periods as well as of general overhauling must be determined by service conditions and the equipment. Some roads have established inspection on the mileage system, while others inspect on a five-day or ten-day basis. The general overhauling period must be determined by the life of bearings, pinions, commutators, trucks and brake rigging, but in no instance should it be longer than one year.

Inspection. It seems to be the general practice on most roads to inspect on a 1000-mile basis. At this period each car should be placed in the shop and all detail parts, such as contact pins, shunts, cotter keys, arc shields, carbon brushes, brush tension, etc., should be thoroughly examined. The control and motors should be blown out with com-

pressed air. All insulators and parts subject to wear should be wiped clean. The lubrication of bearings should be cared for by seeing that they are properly packed, with the waste placed firmly against the journals, and the oil in the bearings gaged to show the proper quantity. In fact, every detail on the car should be put into shape to run until the next inspection.

General Overhauling.—The intervals between general overhauling should be determined by service conditions. When overhauling an equipment all of the apparatus should be taken apart. The control and auxiliary apparatus should have the insulating parts thoroughly cleansed and, if of fibrous material, should be thoroughly painted with a good insulating varnish or shellac, the latter preferred, as it gives a durable, hard finish which can easily be cleaned. All badly worn parts should be replaced. If not entirely worn out, they can be used on other cars to replace broken parts or parts worn too badly to last till the general overhauling.

Motors.—The motors should be taken apart, and the field coils and brush holders removed from the frame. The field coils and wiring should be thoroughly cleaned and painted with a good grade of moisture-repelling insulating compound. The armature should be blown out with compressed air, the commutator turned and slotted and any loose bands replaced. It is good practice to spray the armature thoroughly with a good finishing varnish. By using a spray the varnish will penetrate all of the crevices and materially strengthen the insulation. The brush holders should be carefully inspected and badly worn parts replaced. It is also very important to check up the size of carbon brush holders and to keep a careful record of the same so that brush holders can be ordered with a minimum clearance in the holder, which should not be more than 0.005 in. to 0.01 in.

Car Wiring and Light.—The car wiring should be inspected to see that there is no chafing, that all connections are tight and properly cleated, and all exposed insulated wire should be painted.

Brakes and Mechanical Parts.—The brake rigging and mechanical parts should be carefully inspected and doubtful parts should be renewed.

Air Compressor.—The motor on the compressor should be treated like the car motors. The compressor bearings should be gaged, and if excessive wear is found the bearings should be renewed. The condition of the gears should be checked up. It is advisable to note whether the wear on packing rings and valves is excessive. After the compressor has been thoroughly cleaned and reassembled it should be tested to see that there are no leaks in the gaskets or valves.

Reversing Cars.—One of the most serious abuses on the part of motormen is the practice of reversing on four-motor equipments. On some roads the motormen apparently are permitted to do this on the slightest provocation. This practice is the direct cause of a great many car failures, such as broken gears, pinions, short-circuited commutators, burned brush holders, burned reversers, etc. Whenever a motorman finds it necessary to throw the reverser in order to avoid an accident, the matter should be reported so that an inspection may be made of the commutator, brush holders and reversers. If necessary, these parts may be cleaned up, thus avoiding a probable delay in service if the damage is permitted to continue after the car has been "bucked."

GRADE OF LABOR

The maintenance and inspection problem is comparatively easy to solve on the large urban properties, where men may be trained to specialize as controller inspectors, air-brake inspectors, motor repair men, etc. On most of the smaller properties there is not enough work of one character to warrant such an organization; therefore a few all-round handy men must be employed. In such cases it is usually economy to secure high-grade men.

Many roads make the serious mistake of employing the cheapest labor for oilers, because it is rather a dirty job, while it is a fact that the most expensive repairs are caused by improper lubrication. The Galena Signal Oil Company is doing good work in improving lubrication conditions by sending out men to deliver lectures on this subject in various shops.

TECHNICAL GRADUATES IN RAILWAY SHOPS

The large railway companies have regular apprenticeship courses for young men in their shops and special courses for technical graduates. The writer would strongly recommend that the managers of small properties arrange their organization so that a fairly attractive position such as assistant foreman, assistant to the master mechanic or superintendent will exist for the technical graduate. The smaller roads offer much better opportunities to the technical graduate who is anxious to secure experience than do the larger properties because each day he is brought into close contact with every detail in connection with the maintenance and repair of the entire equipment. On the larger properties, however, he must work in some one shop department at some particular specialty, where he does not get the full benefit of exercising his judgment and resourcefulness in seeing the car as a whole brought in for trouble and in handling such repairs as the requirements of the transportation department make necessary.

In general, the work in a small shop does not appeal to the average technical graduate. Probably he thinks the opportunities for advancement are greater in the larger corporations, and also there is a feeling among the rank and file of the workmen that so-called book learning does not amount to much. Hence shop life is not very pleasant for the technical graduate unless he has enough good sense to drop all his college manners, to make it clear to his fellow workmen that he does not consider himself any better than they are, and to be as willing to learn as he may be to teach.

Many small properties could well afford to create such a position as engineer of car equipment for a college man and have him report to the master mechanic. It would be his duty to see that a proper record is made and filed of the dimensions of all axles, gears and pinions, armature and axle bearings, truck and wheels, etc.; to work toward the standardization of air piping, hanger and other details in order to reduce unnecessary stock; to keep life records of all wearing parts, such as wheels, gears, trolleys, bearings, etc.; to supervise all methods of testing armature fields and circuit-breakers; to check up old gear ratios for determining whether energy is being wasted, etc.

On the average small railway the manager or superintendent looks to the general foreman or master mechanic for everything. In most cases, this subordinate is a very good man who gets along fairly well with the everyday tasks but who has no time to look into economies and check things up; nor has he usually an assistant of sufficient technical knowledge to whom he can delegate such statistical and analytical work. It is for such situations that we recommend the selection of a technical graduate.

The report of the Railroad Commission of Ohio for the year ended June 30, 1911, shows that fifty-six passengers were killed on steam railroads, or one out of every 748,437 handled; that thirteen passengers were killed on interurban roads, or one out of every 11,939,684 handled; that 268 employees were killed on steam railroads, or one out of every 390 employed; that eight employees were killed on interurban roads, or one out of every 1226 employed. The number of employees injured on steam railroads was 9252, or one out of every eleven employed, while the number of employees injured on interurban roads was 135, or one out of every seventy-three employed. The steam railroads carried 41,912,486 passengers, while the interurban railways carried 155,215,899 passengers.

THE OHIO ELECTRIC SUPER-ELEVATION DIAGRAM

The engineering department of the Ohio Electric Railway, with Gaylord Thompson as chief engineer, has distributed to its roadmasters and section foremen a diagram showing the correct super-elevation to be used on the outside rail for various speeds and curves. The curves on the diagram, shown in the illustration, have been plotted from the accepted super-elevation formula. The limits which the company considers are proper for safe elevation and speed are shown by the irregular heavy black line. The speed of cars and elevation of outside rail must be inside this line. Thus, on a 4-deg. curve the track elevation, according to this diagram, should not exceed 4½ in. and the speed of the car should not exceed 40 m.p.h. On a 20-deg. curve the elevation should not exceed 6 in. and the speed 21 m.p.h. For a 50-deg. curve the figures are respectively 3 in. and 9 m.p.h. A note on the chart says that where line poles are spaced 100 ft. apart four times the number of poles passed in seventeen seconds is about the speed of the car in miles per hour. The broken line designated as one-half the speed at which cars would overturn on level track was computed by using the super-elevation formula in transposed form.

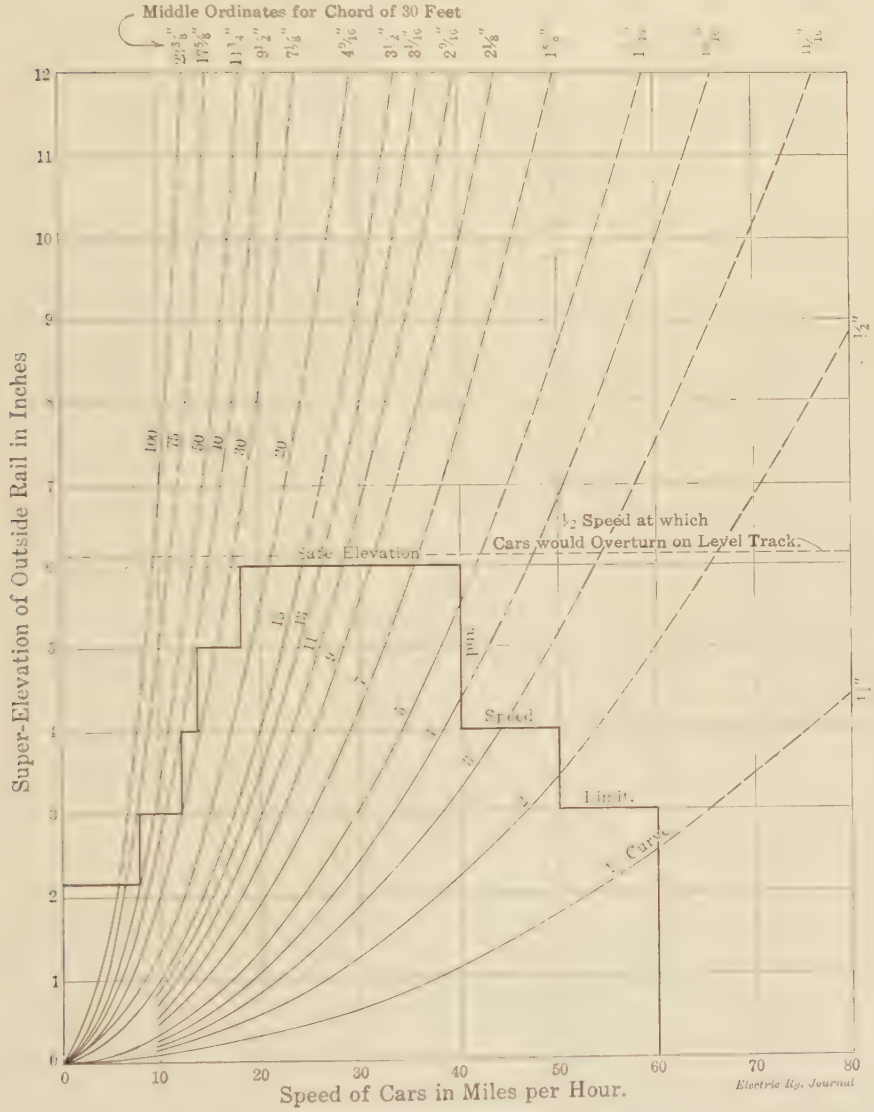

Middle Ordinates for Chord of 30 Feet
Super-Elevation of Outside Rail in Inches
½ Speed at which Cars would Overturn on Level Track.
Safe Elevation
Speed Limit.
1 Curve
Speed of Cars in Miles per Hour.
Electric Ry. Journal

Diagram Showing Correct Super-Elevation to Be Used on the Outside Rail for Various Speeds and Curves

Trackmen as a rule are unable to determine accurately the degree of curve. They depend usually on their ability to compare by observation any given curve with one of known curvature. Hence to the diagram information has been added by which the trackmen can easily determine the degree of any curve. At the upper part of the diagram, at the ends of the lines representing the super-elevations of each curve, the mid-ordinates for a 30-ft. cord are given. These mid-ordinates are not wholly of assistance in determining the degree of curve and in checking the super-elevation, but are very valuable to check the curvature when rails are being bent to sharp curves with a roller bender.

The outer rails of all curves on the Ohio Electric Railway are being elevated to conform to the super-elevations given on the diagram, in general repair work and on new track construction. The diagram has been in use for several years.

A STANDARD METHOD FOR REBABBITTING BEARINGS

The mechanical department of the Cleveland, Painesville & Eastern Railroad Company, instead of leaving the procedure followed in babbitting bearings to the individual ideas of the workman, has prepared a standard set of instructions to be followed in doing this work. The instructions are as follows:

"Prepare the shell by melting out all the old babbitt and chip and file the edges of the lubrication holes and oil groove recesses, leaving them clean and smooth; then heat the shell sufficiently to drive off any moisture. Rub the surface to be tinned with a cloth saturated with a zinc chloride soldering solution. Coat any machine part of the shell not to be tinned with a thin mixture of graphite and water. Dip the shell thus prepared in a pot of a half-and-half solder which should be kept at a temperature between 315 deg. C. and 370 deg. C. Leave the shell in the solder until it is just hot enough for the solder to run off, leaving a thin coating. Remove the shell from the pot and thoroughly rub the surface to be coated with a swab saturated with the zinc chloride soldering fluid, making sure that all parts have an even coating. Rub the tinned surface with clean waste to remove any oxide or other foreign matter and brush the graphite from the untinned parts. The mandrel should be large enough to leave after babbitting at least 0.020 in. for finishing. Close the lubrication holes with a cylindrical piece of sheet iron, pouring them solid with the lining, and then clean them out afterward with a hot iron. The temperature of the blocks at the pouring should be the same as that of the shell. The babbitt should be kept at a temperature between 350 deg. C. and 475 deg. C. Dip the metal from the bottom of the pot to insure thorough stirring. To avoid pocketing air pour in a steady stream, about 3/16 in. in diameter, directly down around the mandrel. Perform all operations from tinning to pouring inclusive as rapidly as possible, not allowing the bearing to cool. Blow holes should be sealed with a hot soldering iron, using the same babbitt. Remove the babbitt from the lubrication holes with the hot iron, file the edges smooth and clean out the oil grooves. Finish bearing in accordance with design."

The use of this formula has been followed with excellent results on the road in question.

PERFORMANCE OF AUTOMATIC BLOCK SIGNALS ON THE INTERURBAN LINES OF THE WASHINGTON WATER POWER COMPANY

BY RUSSELL A. WILLSON, GENERAL SUPERINTENDENT OF RAILWAYS, WASHINGTON WATER POWER COMPANY

Automatic block signals controlled by continuous track circuits were installed on our lines out of Spokane, Wash., in 1910 and were described in the Electric Railway Journal of Dec. 17, 1910. The operation of these block signals has been very satisfactory and some data regarding their performance may be of interest to other roads.

We have kept accurate record only from Jan. 10, 1911, to the present date, as before that time all of our cars were not equipped with the automatic stop device. Our passenger cars have been fitted with the automatic stop device for about sixteen months, and the freight since Jan. 10, 1911. From Jan. 10, 1911, to March 1, 1912, our results have been very satisfactory. We have had on the average only one signal failure to 28,650 movements. This year we expect to do very much better, as at the time we installed our block signals we had two of the longest track circuits in the United States and last summer we had considerable trouble with one of these circuits on the line between Medical Lake and Cheney. This was due to trouble in keeping the relays balanced. One-third of the failures which are chargeable to the operation of the signals occurred on this section. However, this has been overcome and we have not had in the last four months a failure on this circuit.

We have also worked under rather peculiar conditions which may be of interest. On the second long-track circuit —15,000 ft.—during the floods this spring we had at one time 1200 ft. of track under water and during this time the signals worked correctly.

The results obtained from the automatic stop device have also been extremely satisfactory. We have had no trouble at all with this apparatus. It has proved a successs under all conditions of weather, and we are thoroughly satisfied with it. It has not had a single failure.

The patented automatic device is a glass tube on top of the car which is connected into the air-brake system of the train. If a train should attempt to pass a signal with the semaphore at danger the glass tube is broken by the arm on the semaphore. The apparatus is arranged so that in case of line failure or signal failures the signal at danger can be "locked through" by the crew. This portion of the device has also worked very satisfactorily. During the summer season, with the extremely heavy regular traffic and also a number of extra trains working in two sections, we have had no trouble whatever in loss of time or delays on account of the signals.

One of the strong points in favor of the block signaling with the automatic stop is the absolute check upon the operating crews, and we find this year that our crew efficiency is practically 100 per cent.

In summing up our experience with this installation, we can say that from the standpoints of safety to passengers and equipment and increased efficiency of the train crews we feel that the expense in equipping our line with automatic stop block signals has been more than warranted. Another good thing is that our signal maintainer who looks after the operation of the signals has plenty of time to look to the telephone equipment with which we do our dispatching, to the light signals and to the signals used at the various flag stations. He is also able to undertake all small repair work on the line. We feel that he has saved us a considerable amount of money and also has improved the efficiency of the entire system.

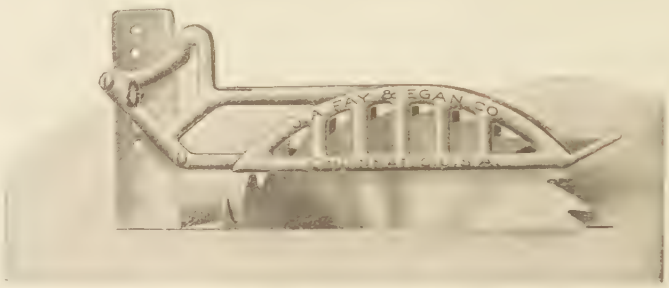
Our signals were made and installed by the General Railway Signal Company, Rochester, N. Y., and are that company's No. 2-A upper-quadrant, a.c. type.

A NEW TYPE OF FARE BOX

The Recording Register & Fare Box Company has placed on the market a new type of steel fare box, which will be known to the trade as the New Haven fare box, type No. 10. This machine differs entirely from the former types made by the company. Its mechanism is so simple that it contains only six springs. The gears and pinions are not punched from sheet steel, but are machine-cut. The device for measuring the coins is of drop-forged hardened steel. The fare box handles nickels, dimes and cents, and will be furnished to register in dollars and cents or in fares as preferred by the customer. It is said that the safety devices embodied in this box make it absolutely impossible to break the mechanism, thus reducing the question of maintenance to the lowest possible point.

A SIMPLE ALUMINUM SAFETY GUARD FOR CIRCULAR SAWS

The attention which is now being given to the protection of operators of woodworking tools has led the J. A. Fay & Egan Company, Cincinnati, Ohio, to develop a saw guard which is made of aluminum. The use of this metal permits an exceptionally light hood of a design which does not interfere with the operation of the saw nor mar the work



Circular Saw Fitted with Aluminum Safety Guard, Showing Holes for Adjustment

in any way. Neither will the hood damage the blade should it be forced against it. As shown in the accompanying view, the guard is mounted on a steel standard set into a plate which is countersunk into the table. The standard is easily removed, while the hood is quickly set for various thicknesses of stock or thrown back when not required. This guard is believed to afford complete protection to the operator without decreasing the efficiency which is obtainable from an exposed saw.

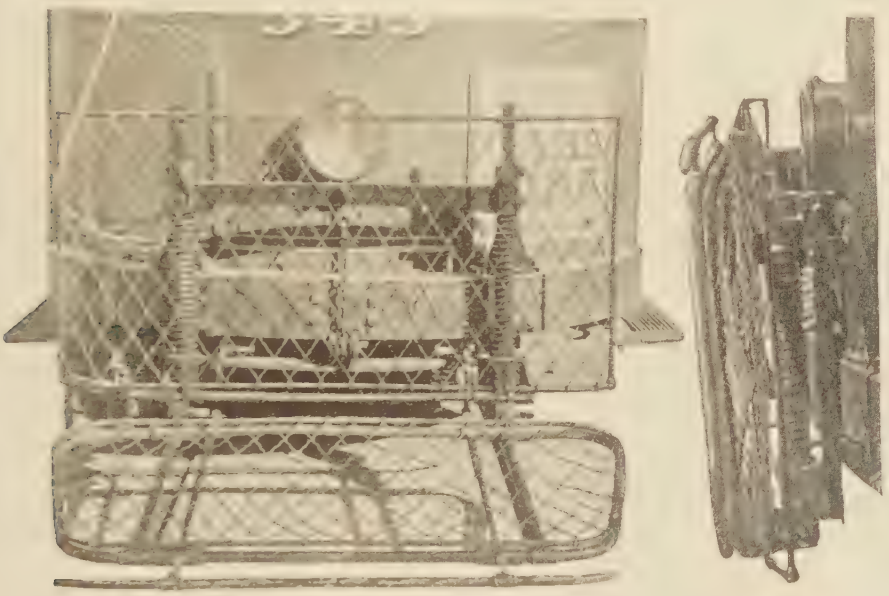
COOLING METAL-CUTTING TOOLS

Some investigations by N. N. Sawwin, published in German, in *Dingler's Polytechnic Journal*, indicate that the liquid which is used for cooling tools for cutting steel should have a lubricating effect as well as an ability to abstract heat. In working cast iron, water was stated to be the most efficient. The investigations were undertaken for the purpose of elaborating the well-known tests made by F. W. Taylor, which indicated that the use of water on cutting tools increased the efficiency of a lathe up to 40 per cent for cutting steel and up to 16 per cent for cutting cast iron. It was found that the lubricating effect of the cooling liquid was very marked when used on metal which gave a long shaving, probably because the lubricant took up in some degree the enormous pressure between the cutting tool, the work and the chip. The author found that linseed oil gave the largest saving in power, and that machine oil was next in order. Emulsions of water, oil, soap and soda, soda solutions and water were found to have no appreciable lubricating qualities.

AUTOMATIC AIR-CONTROLLED FENDER USED IN PORTLAND

The Portland (Ore.) Railway, Light & Power Company has recently adopted the air-controlled fender hereinafter described after two years' experimenting in co-operation with the municipal authorities and the fender manufacturer, the Western Automatic Fender Company, Seattle, Wash. The railway has had 100 of these fenders in use for a year, but will soon equip all of its city cars with a total of about 1100 fenders. This fender has been legally sanctioned by the Portland City Council.

The basic features of this fender were patented in 1909 by F. A. Nelson, Minneapolis, Minn. In principle the fender is operated just like an air brake. The equipment includes an air cylinder which is fastened underneath the car. The piston within this cylinder projects against a pivoted lever, the opposite end of which is connected to an ordinary brake chain, which runs on a small wheel at the lower edge of the car bumper and thence in front of the bumper to the top of the fender frame, at the center, where it is securely fastened. The impact of the piston against the lever projects its chain end backward and thus throws the fender vertically to the track or pavement. By a change in the pivotal point of the lever, the speed of the fender can be greatly increased even over that of the piston. The fender apron is securely locked and has only sufficient play or lost motion to permit it to ride over rough paving or projecting rails. When the apron strikes the rails, it is held there by several hundred pounds air pressure, so that no object can get underneath it. As it is a little more than 1 in. in thickness at the front edge, the fender apron acts as a scoop in getting underneath any object on the track.



Portland Fender as Installed on the Car and as Folded

The air fender is operated by the motorman with the handle which is used for the air brakes. Nevertheless, he can make all crossing and traffic stops, even using emergency applications without operating the fender. In the event of an accident, the motorman throws his brake handle to the full limit of the quadrant. In doing so the brake handle strikes a projecting trip-finger which opens the special fender valve and admits the main reservoir air pressure into the fender cylinder. Thus the operation of the fender is coincident with the throwing over of the motorman's brake handle. An automatic trip-rod is carried 3 in. in front of the apron and parallel with it. This rod rests against the trip-fingers, and when it touches any object on the track it trips open the fender valve just as the motorman does when he throws his handle over. Every operation of the fender also serves to set the air brakes.

To raise the fender back into its normal carrying position, the motorman simply releases the air from the cylinder and the fender is returned to position by the release springs upon which it rides. The fender is carried on adjustable brackets to suit any height or style of car. When a locking bar is withdrawn the fender can be folded up against the life guard, in which operation it automatically locks itself in a vertical position for the back end of double-end equipment or for carhouse storage. As both the apron and life guard fold vertically against the front end of the car, very little extra space is required for car storage. An ingenious suspension device permits the removal of the fender in less than two minutes without drawing a pin or bolt. The apron and life guard are constructed of fluted woven-wire mesh, diamond shape, with 3½-in. openings. The life guard rests on steel springs, to make the impact less severe when an object is thrown against it. The weight of the fender is about 165 lb.

OREGON 1200-VOLT D. C. RAILWAY SYSTEM

The Oregon Electric Railway, a single-track road winding through the picturesque and fertile Willamette Valley of Oregon, will be, with its extensions now under construction, one of the longest electric lines in the country operating on 1200-volt direct current. The United Railways is also part of this system. At present the Oregon Electric Railway extends from Portland, the metropolis of Oregon, to Salem, its capital, 50 miles, with branches from West Woodburn to Woodburn, 3 miles, and from Garden Home to Forest Grove, 19 miles. The main line extension now being built will run from Salem through Albany to Eugene, 70 miles, and an additional branch will be put through from Tualitin to McMinnville, 31 miles, in the near future.

The power of the Portland Electric Light & Railway Company, taken from 60,000-volt, 33-cycle, three-phase lines, will be used. On the present distribution system of the existing main road the operating current will be changed from 600 volts to 1200 volts d.c. and essential alterations will be made in the substations at Moffat, Multnomah and Tonquin. A new substation will be built at Waconda and four approximately equidistant stations located along the new route from Salem to Eugene, in which the equipments will be five 500-kw, 1200-volt rotary converters with necessary transformers, switchboards, lightning arresters and complete substation equipments for stepping down and transforming the 60,000-volt a.c. to 1200 volt d.c. The apparatus equipment will also include one 500-kw portable substation. At Salem two 2250 kva, 60,000/11,000-volt water-cooled transformers are to be installed.

The new rolling stock additions comprehend two 50-ton electric locomotives and four 60-ton locomotives, each with four-motor equipments, for freight haulage; also thirty-one four-motor 100-hp car equipments with type "M" automatic relay single-end control for operation at full speed on either 600 volts or 1200 volts. The apparatus and equipments are being furnished by the General Electric Company, Schenectady, N. Y.

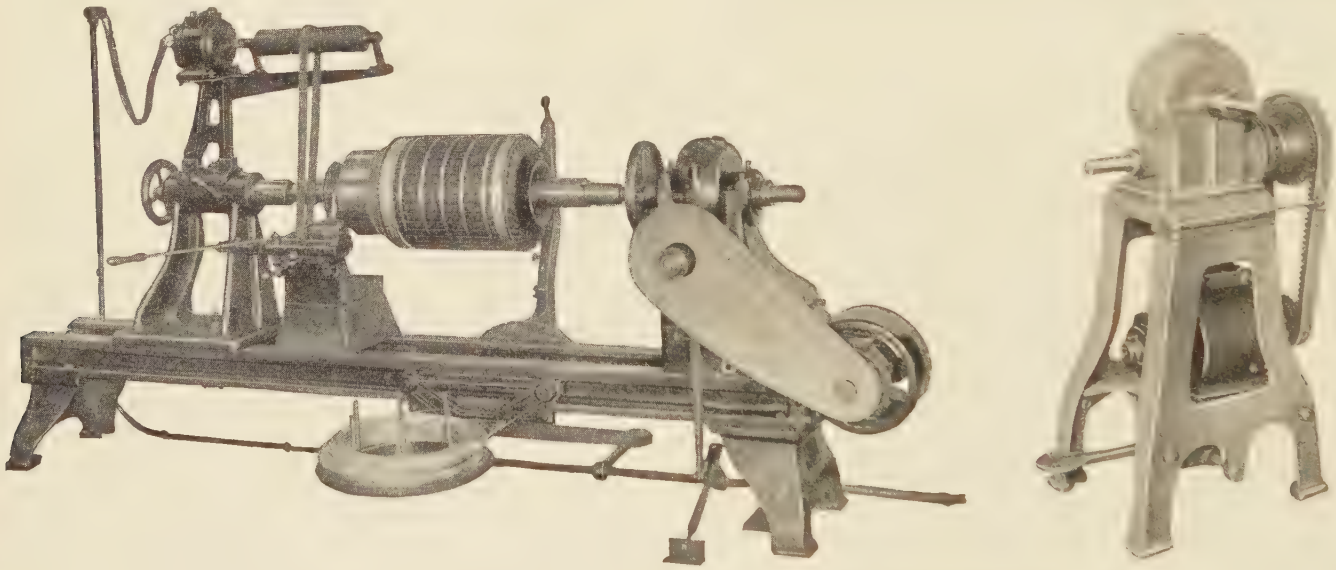
The women employed by the Brooklyn (N. Y.) Rapid Transit Company as station agents on its elevated lines have been furnished with police whistles by the company to supplement the telephone as a means to summon the police.

ELECTRIC SHOP TOOLS WITH SILENT CHAIN MOTOR DRIVE

The American General Engineering Company, New York, has added to its extensive line of electric shop tools several which are arranged for silent chain motor drive. Two of these tools, namely, a coil winder and a combination banding, slotting and truing machine, are shown in the accompanying illustrations. This use of silent chain drive, in addition to other desirable features, has led to the adoption of one or more of these tools by several important railways including the Pennsylvania Railroad and the Brooklyn Rapid Transit System.

The coil winder is an interesting example of the compactness secured by motor drive. The motor is carried between the legs of the winder frame, so that the entire floor space taken by the machine does not occupy more than 4 sq. ft. The weight of this tool is very little more than if it were run by belting. On account of its portability, it can be readily transferred from place to place and operated wherever power is available. The lower shaft of the winder is run through gearing at a standard speed of 30 r.p.m. for armature and field coil work. It is adjusted for operation on either the right-hand or left-hand side. The upper shaft, which is driven through a worm transmission at 680 r.p.m., is used for high-speed winding as on magnet coils. To protect them from dust both the gear and worm drives are completely inclosed as shown. They are also run in grease to insure perfect lubrication. The top casing is split in the center so that the transmission apparatus can be easily inspected merely by removing two bolts. The illustration does not show that the chain is also inclosed. The motor is of ¾-hp or 1-hp capacity and is arranged for variable speed operation by means of a controller, thereby dispensing with all mechanical speed-changing devices. The winder is self-contained and can be furnished with revolution counters to record the number of turns of the shafts, if such a counter is desired.

The view of the combination armature machine shows that the motor for banding work is placed on the driving end where it does not interfere with the carriage on which the wiring and tension arm are placed. The chain is inclosed in a dust-proof case. In banding, the wire is placed on the carriage on the side opposite the operator and is carried through to the tension arm. This arm has tool steel friction plates which are adjusted through a thumb screw fastened on a spring. The adjustment of the tension plates by means of the spring equalizes any irregularities or kinks so that the wire passes through the tension arm without any variations which would cause breakage. The thumb screw adjustment is made by the operator with one hand while he continues to run the machine with the other. The illustration also shows a second independently driven motor mounted on the tailstock. This motor drives a small circular commutator slotting saw. Transverse motion is given to the slotting mechanism by a lever which has a stroke of from 8 in. to 12 in., while adjustment back and forth is made by means of a screw feed. The bed of the slotter is also arranged to receive a grinding or truing tool. This combination machine is made in two sizes, namely, 26-in. swing and 5-ft. centers for standard street railway service and 36-in. swing and 6-ft. centers for interurban, elevated and other heavy work.



Combination Armature Machine and Coil Winder, Both with Silent Chain Motor Drive

NEW ELECTRIC LOCOMOTIVES FOR SOUTHERN PACIFIC COMPANY

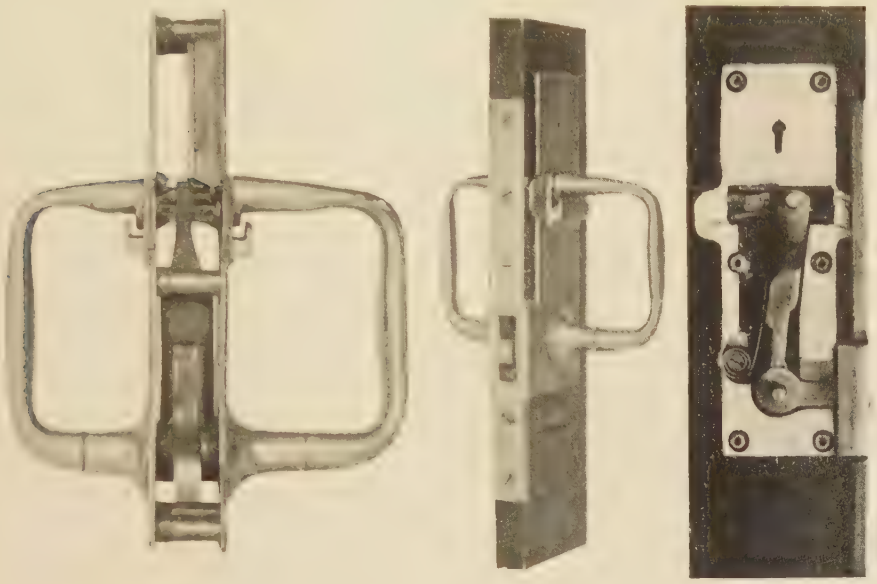
The Southern Pacific Company has purchased six direct-current 60-ton Baldwin-Westinghouse electric locomotives and twenty Westinghouse motor equipments with HL control for operation on the Southern Pacific and the Pacific Electric Company's properties. Both the car and locomotive equipments are arranged for operation on either 600 volts or 1200 volts.

The locomotives, each of which will have an aggregate motor capacity of 1000 hp, will be the largest 1200-volt locomotives ever built. They will have quadruple equipments of the No. 308-B-7 commutating pole motor, which is a 600-1200-volt motor rated at 225 hp at 600 volts with natural ventilation and 250 hp at 600 volts with forced ventilation. Mechanical parts for the locomotives will be furnished by the Baldwin Locomotive works. The cabs and frames will be entirely of steel. A Westinghouse dynamotor-compressor will be used on cars and locomotives for operating the air compressor and for furnishing 600-volt current for both control and lights when the equipment is on 1200-volt sections of the line. The twenty passenger cars will be furnished by the Pullman Palace Car Company. Each car will have quadruple equipments of Westinghouse No. 327-C 50-hp commutator pole motors and Westinghouse HL control.

According to Consul General David F. Wilber, Vancouver, B. C., a representative of the General Electric Company recently inspected the line of the Canadian Pacific Railway between Cawlegar Junction and Rossland, B. C., with a view to its electrification.

DOOR LOCK FOR DOUBLE SLIDING DOORS

The Columbia Machine Works & Malleable Iron Company, Brooklyn, N. Y., has just brought out a lock for a double sliding car door which, on account of its simpler construction, should withstand wear and abuse much better than the ordinary types. As shown in the accompanying interior view, the principal feature of the lock mechanism is the use of a locking bar. The upper end of this bar is drilled to receive a round pin upon which the grab handle is carried, while the lower end is drilled to receive a similar pin upon which the hook or latch casting is pivoted inside the locking bar. The only other mechanism for the normal



Exterior and Interior Views of Door Lock

operation of the door consists of a powerful flat spring attached to that part of the hook casting which is pivoted inside the locking bar. It is apparent from this description that when the grab handle is operated the upper pin serves merely to push the locking bar to a vertical position, thereby compressing the spring and pulling over and raising the hook. The release of the spring, of course, returns the hook to its normal position. As the pins are not subject to any wear, lost motion is entirely avoided.

This door lock contains several other features besides the improvement in the operating mechanism. Thus there is a shutter on each side of the slot between the top of the locking bar and the grab handle to keep the lock free from dust. The edge of the door at the lock is mortised for a brass piece ⅜ in. thick by 12½ in. long to prevent multilation of the door from violent closing. Another unusual feature is that the nosing piece on the edge of the opposite door has a set screw to adjust the nosing ¼ in. to ½ in. either up or down. This makes it easy to keep the hook in perfect alignment with its socket, despite carpenter's errors or the effects of rattling, shrinkage, etc.

CARS FOR THE 1500-VOLT PIEDMONT LINES

The accompanying illustration shows one of twenty-three cars built by the Jewett Car Company, Newark, Ohio, for the Greenville, Spartanburg & Anderson Railway and the Piedmont Traction Company, both of which are to be operated with Westinghouse 1500-volt d.c. equipments. The cars were built and equipped to conform in every particular to the high standard of construction which was adopted throughout for the greatest interurban railway system of the South. The car bodies are finished in selected mahogany except for the baggage compartment, which is finished in ash, and the saloons of white enamel. A leaded glass of rich design is used for both the inside and outside gothic sashes. The fittings and trimmings are also of the highest grade for high-speed interurban electric cars.

The regular passenger section of each car is divided into compartments for white and colored patrons. The negro compartment, which is situated in the front part of the car next to the baggage section, has the same class of finish, seats and saloon fixtures as the other passenger compartments. In order to make the negro compartment accessible without passing through the main compartment and still to have the baggage compartment no longer than necessary for baggage service, the bottom framing under the baggage door was furnished with triple steps similar to those used on the rear platform. The trap door in the bottom framing is therefore arranged to carry the baggage door track as well as to close such part of the baggage door opening as remains between the step hanger and the doorpost, thus making the baggage compartment safe for the use of passengers. The cars are equipped for train service. Furthermore, while intended for running in one direction only, they can be operated double-end when necessary. The electrical equipment of these cars was described in the Electric Railway Journal of Feb. 3, 1912.

The cars are 60 ft. long over all and divided into four compartments as follows: Baggage compartment, 9 ft. 8 in. long with folding seats; negro compartment, 7 ft. 11⅞ in. long; main compartment, 24 ft. 10¾ in. long; smoking compartment, 11 ft. 3¼ in. long; vestibule, 4 ft. 3 in. long. The width of the cars over the side posts is 9 ft. 1 in. Separate toilet facilities are provided in the negro and main passenger compartments.

Combination Passenger, Smoking and Baggage Car for the Piedmont & Northern Lines

LONDON LETTER

(From Our Regular Correspondent)

The completion of the Immingham Dock, on the other side of the Humber from Grimsby, necessitated a new means of communication between Grimsby and the docks. This need is being met by the Grimsby District Light Railway, a single-line route more than 5 miles long equipped with electricity. It is the first section of an electrically operated railway to be built by the Great Central Railway. The overhead system is used with direct current at 500 volts. Power is distributed from the Immingham station through a substation, the primary supply being three-phase, 6600 volts, 50 cycles, alternating current. The substation apparatus was supplied by the British Westinghouse Company. The special rolling stock, which consists of steel underframe cars with a seating capacity of sixty-four passengers each, and smaller cars, with a seating capacity of forty passengers each, has been supplied by the Brush Electrical Engineering Company. The electrical equipment for the cars was furnished by Dick, Kerr & Company. The cars are geared for a speed of 25 m.p.h. There are two 50-hp motors on the large cars and two 35-hp motors on the small ones.

In addition to the electrification of the various lines already referred to in these columns, the London & South Western Railway, which as yet has no lines operated by electricity, has decided to electrify one of its loop lines which extends from the main line at Merton through Kingston, Teddington, Twickenham, Richmond, Mortlake, Barnes, Putney and Wandsworth, returning to the main line at Clapham Junction. This company has recently spent a considerable sum in building a new station at Waterloo, and the electrification scheme will involve some of the tracks of the main line from Waterloo to Merton.

The Central London Railway (the original "Twopenny Tube"), of which Horace F. Parshall is managing director, has applied for an extension of its lines to Richmond and Kingston via Chiswick and Kew. This railway is completing its extension from the Bank to Liverpool Street Station and proposes to build an extension from its western end at Wood Lane to Ealing, where it is to connect with the Great Western main line. The Central London Railway will in a few years change its aspect from an underground artery in London to a short trunk line, operating from Liverpool Street Station and tapping the whole Thames Valley. The population of the districts to be covered is quite dense, and there are three suburban racecourses in the area, namely, Kempton Park, Hurst Park and Sandown Park.

The Accrington Corporation has applied for powers to borrow £33,750 for electric extensions and has decided to adopt gas engines to drive the electric generators. It is intended to have a producer plant with ammonia recovery. The first installation will be capable of developing 2,000 brake-hp, but arrangements will be made to add four similar units if required. The initial installation will consist of two gas engines, two high-tension generators, two exciters and two water coolers. The gas producer plant will cost £8,000 and the gas engines and generators £13,500. It is expected that £1,100 per annum will be saved on a 60 per cent load factor on 2,000 brake hp, allowing 12½ per cent for interest, sinking fund and repairs, with coal at 10 shillings per ton, while £1,250 additional will be obtained from the by-products.

The annual dinner of the Tramways & Light Railways Association held recently was the largest and most successful dinner that has ever been held by this association. The Duke of Argyll, the president of the association, was unable to be present, and Alderman Smithson, Leeds, proposed the health of the guests and welcomed the members of the Municipal Tramways Association who were present. The Right Hon. A. Lyttleton replied. He said that the present condition of affairs as regards the coal strike was deplorable, but rendered homage to the excellent work done by the association in transporting the population and in town planning. Mr. Blain, the president of the Municipal Tramways Association, agreed that the difference between corporation and company administration was emphasized too much and assured the members of the association that he would do everything in his power to bring about greater co-operation between the two associations.

The arbitration proceedings relating to the purchase by the London County Council of the portions of the London United Tramways within the County of London have been published. The principal question involved was whether the purchase should include the power station of the London United Tramways at Chiswick, which is necessary at present for the tramways system. The Council is not anxious to take over this station, as it has its own sources of power. The arbitrator has decided the Council shall purchase the station at a price of £220,000, this price not to include some of the engines and boilers. The decision is being criticised and is expected to lead to further special cases being determined in the courts. Forty-five cars are to be purchased by the Council and made part of the property which is to be taken over. The carhouse, it is understood, is to remain the property of the company.

The Glasgow Corporation Tramways at present discontinues its car service about midnight. Efforts have been made to have the company establish a limited service after this hour, and Mr. Dalrymple, the general manager of the tramways department, has requested every person who is required to travel regularly between the centre of the city and the outskirts between midnight and 3 a. m. to communicate with him, giving particulars in regard to occupation, address, approximate hour of leaving the center of the city or the outskirts and the most direct route suitable, so that a special committee may give the matter proper consideration.

The Board of Trade inspector has inspected the Brighton Company's lines between Peckham Rye and Tulse Hill, and the lines have been opened to the public. It is thus possible to travel by electric trains from London Bridge, through East Dulwich, North Dulwich, Tulse Hill, Streatham Hill, and Balham to Victoria, and between London Bridge and the Crystal Palace, via West Norwood and Gipsy Hill.

The East London Railway committee has accepted tenders for the electrification of its line at a cost of £100,000, and the work will be started at once. This railway, which runs from Shoreditch to New Cross, is 7 miles long, and is under the joint control of the Metropolitan, the South Eastern and the District railways. The greater part of the work of electrification will be carried out by the engineers of the Metropolitan Railway, and it is expected that the installation of electricity will be carried out with sufficient dispatch to permit the operation of electric trains this year.

The Great Western Railway is trying a petrol-electric coach on one of its outlying lines. The London General Omnibus Company has adopted the straight petrol system for road traction and is developing all routes where 8d. per mile can be earned. The company is turning out twenty-two new 'buses each week from its factory at Walthamstow. The London General Omnibus Company operates most of the omnibuses in London, but there are one or two other companies engaged in furnishing similar service. Messrs. Tillings, who operate a considerable number of omnibuses, have adopted the Tillings-Stevens petrol-electric omnibus and are having a hundred vehicles of this type built for them. The National and the Metropolitan Companies operate steam omnibuses with satisfactory results. The Metropolitan Company's superheated steam vehicles were invented by the late M. Serpollet.

The Belfast Corporation has adopted the recommendation of the tramways committee to accept the tender of £100,390 made by Dick, Kerr & Company, Ltd., to construct and equip the tramway extensions, the work to be completed in six months.

The London County Council has decided, in view of the serious aspect of the coal strike, to curtail the tramway service, and has applied to the Board of Trade for special authority to permit any number of passengers not exceeding fifteen to travel inside the cars, in addition to the full number of seated passengers. No coal is being delivered at the Council's wharf at Greenwich, and if the strike is not settled in a very short time the tramway service may have to be stopped. Although many of the municipalities had on hand when the strike was declared supplies of coal sufficient to last for five or six weeks, the situation has assumed a very serious aspect, as at this writing the strike has been in effect three weeks.

A. C. S.

News of Electric Railways

Rate of Fare Discussed at Toledo

Within a short time City Solicitor Schreiber, of Toledo, and Attorney Rathbun Fuller, who represents the Toledo Railways & Light Company, will discuss the rate of fare to be incorporated in the new franchise of the Toledo Railways & Light Company, Toledo, Ohio. At present the fare is 3 cents for two hours morning and evening and tickets good for the remainder of the day are sold at the rate of six for 25 cents. Mr. Schreiber says that the members of the Council would probably favor an extension of the time for the 3-cent fares to 2½ hours in the morning and 2½ hours in the evening, with seven tickets for 25 cents during the remainder of the day. J. B. Merrill, chairman of the Council committee on street railways, says that he would not favor any rate of fare of more than 3 cents unless appraisal of the property shows that the system cannot be operated at that rate.

The directors of the company met on March 28, but immediately adjourned until April 11. They will take no further action on any of the matters that are pending until after the security holders meet in New York.

At their conference on March 28 Mr. Schreiber and Mr. Fuller agreed that all differences between the city and the company shall be submitted to a board of arbitration of three members, one to be selected by the city, one by the company and the third by these two members. They failed, however, to agree on the method to be used to select the third member in case the first two should fail to agree on the third member. Mr. Fuller suggested that this duty should be left to the judge of the federal court for that district. Mr. Schreiber thought the Public Service Commission should make the selection.

The company has been granted until May 1, 1912, to file an answer to the petition of the United States Mortgage & Trust Company for the appointment of receivers.

Audit of Express Business at Detroit by City

F. W. Brooks, general manager of the Detroit (Mich.) United Railway, appeared before the judiciary committee of the Detroit City Council on March 29, 1912, to explain some points relative to the audit which the city has been making of the freight and express business done by the company. Mr. Brooks was urged to say whether he would allow the city auditors to carry their inquiry further than was contemplated at first so as to secure other data in addition to those which it has so far collected. Mr. Brooks declared that such an audit as the committee mentioned would require several months and would interfere with the routine work of the office. He advised the committee to request the State Railroad Commission to furnish the information desired, as this commission had the right to investigate the books. He told the committee that he would not object to the city's representative coming to the office to see if he could get the information desired within a short time.

Aldermen Gutman and Lynch have filed notice of a reconsideration of the vote of the City Council by which the charter revision election will be postponed until fall. They assert that the expense of such an election in June will be more than overbalanced by the benefits that will accrue from it. The cost of a special election is estimated at $37,000.

Change in Schedule Requested in Cleveland

J. J. Stanley, president of the Cleveland Railway, addressed a letter to Street Railway Commissioner Peter Witt on March 27, 1912, in which he asked that the City Council, through that official, make such changes in the Superior Avenue schedule as will permit the strict observance of the company's contract with the union and still obey the orders of the city. This request was made as a result of the decision of the arbitrators in favor of the men on the Superior Avenue schedule. Mr. Witt and Mayor Baker conferred in regard to the policy to be followed in this matter, but no information was given as to the conclusion reached until the question was laid before Council.

The company was placed in a peculiar position through the decision of the arbitrators. The orders of the City Council in the matter of schedules, which it is required to obey, are in conflict with the terms of the contract which it has with the union. It was suggested that the matter of the good faith of the company in endeavoring to operate under the new schedule should be submitted to arbitration. Mr. Witt holds that the schedules are not subject to arbitration under the Tayler franchise.

Mr. Witt believes from his observations and the testimony given before the board of arbitration that the cars used on the Superior Avenue line are responsible for the inability to operate in accordance with the schedule, and he announced last week that he would recommend the purchase of 200 motors with which to equip these cars.

On March 30 Mr. Witt announced that he would recommend to the City Council that the Cleveland Railway be authorized to purchase power from the Cleveland Electric Illuminating Company. Engineers of the city, the Cleveland Railway and the Cleveland Electric Illuminating Company have agreed on the cost of producing power in plants operated by the last company, but details of their figures have not been given out. The cost is said to be less than 0.759 cent per kw-hr., which was named by the Illuminating Company in its original offer. Mr. Witt has suggested that the company make a contract for the purchase of 15,000 kw on a ten-year basis. The power would thus cost the company about $400,000 per year. This would save $25,000 annually over the price named originally. Substations to cost about $500,000 will have to be installed.

The Cleveland *News* is publishing a series of articles on the character of service that is now furnished by the company under the supervision of the city. Officers of the company contend that the service is as good as can be given with the present equipment.

Full Chicago Unification Resolution

The following are the provisions in full of the resolution which was adopted by the local transportation committee of the City Council of Chicago on March 28 in regard to the proposed merger of the elevated and the surface railways in Chicago and the construction of a subway, referred to briefly in the Electric Railway Journal of March 30, 1912, page 514:

"1. All street and elevated railways in Chicago to be operated as a single system.

"2. Single fare within present and future limits of Chicago, with interchangeable transfers on surface, elevated and subway railways.

"3. Prompt and effective elimination of downtown congestion.

"4. Construction and ownership by the city, and operation by the unified railway system, of a feasible passenger subway system.

"5. Rapid transit service for all parts of the city.

"6. Through routing of all elevated railway trains.

"7. Such routing of all cars and trains as will most evenly develop all sections of the city without discrimination and will prevent congestion.

"8. Operation of enough surface through routes properly to serve the traveling public.

"9. Right of purchase on the part of the city, or a licensee designated by the city, upon terms mutually equitable to city and company.

"10. Payment to the city of a proper portion of net earnings of company after a reasonable return upon capital properly invested."

The chairman of the committee was authorized to obtain the necessary legal, engineering and transportation experts to assist the committee in drawing the ordinance. Each of the railways was invited to designate a representative to assist in preparing a satisfactory ordinance.

A. I. E. E. Railway Meeting.—The 270th meeting of the American Institute of Electrical Engineers was announced for Friday, April 5, 1912, at the auditorium in the Engineers Building, New York, N. Y. The meeting was to be held under the auspices of the railway committee, and Samuel Insull, president of the Commonwealth Edison Company, Chicago, was to present a paper on "Relation of Central Station Generation to Railway Electrification."

Milwaukee Car Tax Invalid.—The ordinance passed early in 1911 to tax each car operated in Milwaukee by the Milwaukee Electric Railway & Light Company $15 was declared invalid recently by Judge W. J. Turner in the suit brought by the company against the city. The court states that in 1905 the system of taxation on street railways was changed to an ad valorem basis, this being a general law, and thus forestalling any attempt at licenses by a city and clearly excluding all other imposts for revenue. The company paid $8,805 as a tax on 587 cars on May 17, 1911, under protest.

Extension of Hudson & Manhattan Railroad.—W. G. McAdoo, president of the Hudson & Manhattan Railroad, which operates under the Hudson River between New York and New Jersey, is quoted as follows in regard to the report that the company had decided not to extend its system in New York from Thirty-third Street and Broadway to the Grand Central Station, at Madison Avenue and Forty-second Street: "I cannot understand how such a rumor originated. We have never considered anything of the kind. Our franchise calls for the beginning of work on April 28, and only the other day we filed an application with the city authorities for an extension of time. The confusion regarding the subway plans as a whole in New York has delayed us, and we are waiting for a final settlement so that we can make our plans fit in with the others."

Personnel of Michigan United Traction Company.—Mention has previously been made in the Electric Railway Journal of the appointment of C. E. Morgan as general superintendent of the Michigan United Traction Company, Jackson, Mich. J. F. Collins, vice-president and general manager of the company, announced on April 1, 1912, the following appointments: R. C. Taylor as superintendent of equipment, with headquarters at Albion; F. W. Haak as electrical superintendent, with headquarters at Jackson; H. K. Sherman as purchasing agent, with headquarters at Jackson; F. M. Farley as superintendent track, roadway and buildings; C. H. Smith as superintendent of transportation at Kalamazoo; E. M. Raver as superintendent of transportation at Battle Creek; Dean McLaughlin as superintendent of transportation at Jackson; W. E. Maloy as superintendent of transportation at Lansing and over the St. John and Owosso interurban division; R. A. Barnett as superintendent of transportation at Owosso.

Franchise Recommended for New York Bridge Line.—The franchise committee of the board of estimate of New York decided on April 2, 1912, to recommend the granting of a franchise to the Brooklyn & North River Railroad, which is controlled jointly by the Brooklyn Rapid Transit Company, the Coney Island & Brooklyn Railroad and the Third Avenue Railway, and with which the New York Railways is in close alliance. It will start its cars from the junction of Flatbush Avenue extension and Fulton Street, Brooklyn, and will run them across the Manhattan Bridge and through Manhattan to the North River. At first they will be operated in Grand Street, Manhattan, but as soon as the electrification of Canal Street is completed they will use that thoroughfare. The Manhattan Three-Cent Fare Line also will run across the bridge, starting at the same point in Brooklyn, but not going further than the Manhattan terminal of the bridge. This company will charge only 3 cents. The Brooklyn & North River Railroad will charge local bridge passengers only 3 cents, but will charge other passengers 5 cents, with the right to transfer to the surface lines in Brooklyn or in Manhattan.

Carhouse Fire in Toronto.—The King Street carhouse of the Toronto (Ont.) Railway was destroyed by fire on Monday afternoon, March 25, 1912, as noted briefly in the Electric Railway Journal of March 30, 1912. The King Street division plant is composed of a large brick carhouse at the corner of King Street and St. Lawrence Street, and at the rear a distance of 75 ft. from the King Street carhouse there was another carhouse about 400 ft. long which extended from St. Lawrence Street to the Don Esplanade. This latter building the company used for storing its summer rolling stock, including its single and double truck cars and trailers. At the east end there was a smaller building of the same type, in which the company housed the rolling stock used during the day. The fire occurred in the small building from some unknown cause, and as the cars there and in the longer building were newly painted and varnished, the flames spread rapidly and consumed both buildings and their contents. The wind was blowing in the direction away from the brick building, which is the company's main operating station, and this, together with the open space of 75 ft. between the buildings, prevented the destruction of the brick carhouse. More than 150 cars were destroyed, among them a number of the new double-truck convertible parlor cars, turned out of the company's shops late in 1911. The car shops of the company have been busy since the beginning of 1911 constructing new cars and orders have been given to continue building other cars until the shortage from the fire is made up and the demands of traffic are satisfied. Under the charter which the company has, it is required to build all its own cars. The company has been unable as yet to determine the amount of the loss on the rolling stock.

LEGISLATION AFFECTING ELECTRIC RAILWAYS

MASSACHUSETTS

The adverse report of the committee on street railways upon the bill to require all electrically operated cars in Massachusetts to be equipped with air brakes has been accepted by both branches of the Legislature. The committee on labor has reported a bill which would provide that a day's work for all conductors, motormen and trainmen employed by street or elevated railways shall be arranged upon the basis of nine hours of platform work. The bill provides that if in any case the schedule cannot be arranged so as to furnish a day's work of approximately nine hours and it is possible to provide one not exceeding nine and one-half hours, the schedule may be so arranged, the platform time above the nine hours to be paid for as an addition to the nine hours' work. The bill would require that the day's work of men employed on regular cars shall be arranged to be performed within twelve consecutive hours. The work of any extra man who is regularly employed may with his consent be arranged in early and late halves or portions, but the bill would require an interval of not less than eight hours between the close of the work of one day and the beginning of the work of the next day, within which no work shall be required except in case of emergency. Nothing in the bill is intended to prohibit spare men from performing as substitutes in case of emergency the work of employees unexpectedly absent. The bill has had a third reading in the House.

NEW YORK

The Legislature adjourned on March 20, 1912, after one of the briefest sessions on record. From the standpoint of the amount of work accomplished and the significance of the acts passed there is little to record. Politically there was a conflict of party authority, with the strange anomaly of a Democratic Senate and a Republican Assembly. The Democratic majority in the Senate and the minority in the Assembly were under the domination of Tammany Hall. On the other hand, the conservative element in the Republican State organization dominated the Republican majority in the Assembly and the Senate minority, and at times the two organizations co-operated to defeat pending measures and to embarrass the Governor. Both of the Governor's first nominations of members to the two State public service commissions were held up. Undoubtedly the most important legislation enacted was the passage of the Wagner bill, referred to previously in the Electric Railway Journal. This measure was drawn to enable the Public Service Commission of the First District of New York and the city authorities to accept without unnecessary delay the "dual" offer for subway construction and operation tendered by the Interborough Rapid Transit Company and the Brooklyn Rapid Transit Company. This bill passed in both houses almost without opposition under an

emergency message from Gov. Dix in the closing moments of the session. The Senate passed the Bayne bill to permit the storage of water and the development of electricity under the State auspices, but the measure was defeated in the Assembly. The Stilwell-Goldberg bill, which provides for free transfers on surface lines in Manhattan and the Bronx at a number of points specified in the measure, was passed in the Assembly, after the committee on rules for the first time in its history was compelled by affirmative action of the Assembly to report a bill. The bill makes effective the order of the Public Service Commission of the First District of New York in regard to the restoration of transfers, and takes from the railroads the right to review the hearings before that body by a writ of certiorari. The only question that can be taken to the courts now is the one of whether such a law is confiscatory. Just before the close of the session the Governor nominated G. V. S. Williams, Brooklyn, for appointment to the Public Service Commission of the First District to succeed William McCarroll, whose term of office has expired, and the nomination was confirmed by the Senate. The Governor did not send to the Senate a second nomination for appointment to the Second District Commission. Governor Dix will give a hearing on the bill providing for transfers on street railways in Manhattan and the Bronx on April 16, 1912, at noon.

PROGRAM OF ASSOCIATION MEETINGS

Iowa Street & Interurban Railway Association

The following program has been announced for the ninth annual meeting of the Iowa Street & Interurban Railway Association, which is to be held at the Coliseum, Des Moines, Ia., on April 25, 26, and 27, 1912:

MORNING SESSION, APRIL 25, 10 A. M.

Call to order.
Address of welcome by James R. Hanna, Mayor of Des Moines.
Response by William G. Dows, Iowa City.
Address of president.
Reading of minutes.
Report of secretary and treasurer.
Paper, "Operating of Limited Trains on Short Interurbans," by P. P. Crafts, general manager of the Iowa & Illinois Railway, Davenport, Ia.
Appointment of committee on nominations.
Appointment of convention committees.
New business.

AFTERNOON SESSION, APRIL 25, 2 P. M.

Paper, "Some Experiences with Prepayment Cars," by R. A. Leussler, assistant general manager of the Omaha & Council Bluffs Street Railway, Omaha, Neb.
Paper, "Gas-Electric Motor Cars," by H. G. Chatain, of the General Electric Company.

MORNING SESSION, APRIL 26, 10 A. M.

Paper, "How to Locate Industries on Your Line," by C. M. Cheney, general freight and passenger agent of the Waterloo, Cedar Falls & Northern Railway, Waterloo.
Paper, "Experiences on Small Electric Properties," by J. P. Walters, secretary of the Tama & Toledo Railway, Toledo.

AFTERNOON SESSION, APRIL 26, 2 P. M.

Paper, "Use of High Efficiency Lamps," by S. E. Doane, chief engineer of the National Electric Lamp Association.
Paper, "Why Railroad Financing in Iowa is Difficult," by F. E. Farwell, secretary of the Waterloo, Cedar Falls & Northern Railway, Waterloo.

MORNING SESSION, APRIL 27, 10 A. M.

Unfinished discussion of papers.
Executive session.

AFTERNOON SESSION, APRIL 27, 2 P. M.

Executive session.
Report of nominating committee.
Election of officers.
Adjournment.

An exhibition of electrical apparatus will be held in connection with the meeting and will be open daily from 9 a.m. to 9 p.m. from April 23 to April 27.

On the evening of April 24 the manufacturers and supply men will tender a complimentary dinner to the members of the association at the Chamberlain Hotel.

On the evening of April 25 there will be a rejuvenation of the Sons of Jove at the Chamberlain Hotel and a theater party.

Southwestern Electrical & Gas Association

The following program of papers and addresses has been announced for the eighth annual convention of the Southwestern Electrical & Gas Association, to be held at San Antonio, Tex., on April 25, 26 and 27, 1912:

Paper, "The Benefit of the Interurban Railway to the Community," by R. B. Stichter, general manager of the Texas Traction Company, Dallas, Tex.

Address, "History of Street Railway Development in Texas," by T. C. Brown, superintendent of the San Antonio Traction Company.

Paper, "Theft of Electric Current and of Gas," by Harold L. Geisse, of the San Antonio Gas & Electric Company, San Antonio, Tex.

Address, "Public Service Corporations and State Development," by Louis J. Wortham, Fort Worth, Tex.

Paper, "Prepaid Meters: Their Advantages and Disadvantages," by George M. Griffith, of the Galveston (Tex.) Gas Company.

Paper, "The Relation of Power Factor to Central Station Costs," by Frank M. White, manager of the Amarillo Water, Light & Power Company, Amarillo, Tex.

Paper, "A Treatise on the Distribution of Electricity from the Central Station," by A. D. Brinkerhoff, assistant superintendent of the Waco Electric & Gas Company, Waco, Tex.

Paper, "Relations That Should Exist Between the Public and Public Service Corporations," by E. W. Kellogg, Jr., manager of the El Paso (Tex.) Electric Street Railway.

"Question Box" discussions.

The program of entertainment which has been arranged for the convention follows:

APRIL 25

2:00 p. m., opening of electrical exhibition.
3:00 p. m., automobile ride for visiting ladies to the Missions.
8:00 p. m., reception by supply men and exhibitors to visiting members and ladies at the electrical exhibit in the Hotel St. Anthony.

APRIL 26

11:00 a. m., electrical exhibition opens for the day.
4:00 p. m., reception for visiting ladies at Country Club.
8:00 p. m., theater party for visiting ladies and delegates.
8:00 p. m., rejuvenation of "Sons of Jove."

APRIL 27

10:00 a. m., reception at electrical exhibition.
3:00 p. m., tour of San Antonio. Mexican supper on one of the plazas.

The meetings of the association will be held at the St. Anthony Hotel, which is in the center of San Antonio, and an exhibit of electrical apparatus will be held in the ballroom of the same hotel during the convention. It is the intention of the committee in charge of the exhibits, of which Martin Wright, San Antonio, is chairman, to build up booths and arrange for all decorations as well as other details. A nominal charge will be made to defray the actual expense of putting in the booths. Manufacturers can arrange to make exhibits at the show by addressing Mr. Wright at the Bedell Building, San Antonio.

The headquarters of the association will be at the St. Anthony Hotel. Application for hotel reservations should be made direct to the St. Anthony Hotel, Gunther Hotel, Menger Hotel or Crocket Hotel. All of these hotels with the exception of the Menger Hotel are run on both the European and American plans. Arrangements have been made with the railroads for round-trip rates of practically one and one-third fare from points within Texas, and the suggestion is made that delegates who attend from the East take advantage of the winter tourist rates to San Antonio. D. G. Fisher, Texas Traction Company, Dallas, Tex.; Sam A. Hobson, manager of the Fort Wayne Electric Works, St. Louis, or Milton Mills, 915 Olive Street, St. Louis, will answer inquiries in regard to the details of the convention.

Financial and Corporate

Stock and Money Markets

April 3, 1912.

Several of the railroad stocks and the copper shares which have played a conspicuous part in recent market operations on the New York Stock Exchange showed net losses to-day, but even larger net gains were recorded in many of the other issues. In volume of trading the dealings closely approximated the record of the earlier days of the week, but in the late trading the market was extremely dull. Quotations for loans to-day were: Call, 2¾@4 per cent; 60 days, 3¼@3½ per cent; 90 days, 4@4½ per cent.

In the Philadelphia market price changes in stocks other than Philadelphia Electric and the General Asphalt were nominal. The market for bonds was quiet.

In the Chicago market the trading in bonds was quite active. Chicago City 5s sold at 102⅞, and Chicago Railways 5s at 100⅞ and 101. The 5 per cent bonds of the Union Loop were traded in at 85.

In the Boston market trading in the industrial and railway issues was quiet. The market for copper shares reacted and declines of one to two points were numerous in the active issues.

In the Baltimore market small sales were recorded of stock of the Augusta & Aiken Railway & Electric Corporation and the United Railways.

Quotations of traction and manufacturing securities as compared with last week follow:

	Mar. 27.	April 3.
American Brake Shoe & Foundry (common)	a96	a96
American Brake Shoe & Foundry (preferred)	a134¼	a134½
American Cities Company (common)	a33½	33½
American Cities Company (preferred)	a82½	82½
American Light & Traction Company (common)	a302	a304
American Light & Traction Company (preferred)	a109	a109
American Railways Company	a44⅛	a44⅛
Aurora, Elgin & Chicago Railroad (common)	a44	44
Aurora, Elgin & Chicago Railroad (preferred)	86	86
Boston Elevated Railway	a134	a134
Boston Suburban Electric Companies (common)	a15	a15
Boston Suburban Electric Companies (preferred)	a77½	76½
Boston & Worcester Electric Companies (common)	a10½	a10½
Boston & Worcester Electric Companies (preferred)	a56	a56
Brooklyn Rapid Transit Company	83¼	83¾
Capital Traction Company, Washington	a125	a125
Chicago City Railway	a190	a190
Chicago Elevated Railways (common)	a35	a35
Chicago Elevated Railways (preferred)	a95	a94
Chicago Railways, ptcptg., ctf. 1	a100	a96
Chicago Railways, ptcptg., ctf. 2	a35½	a35½
Chicago Railways, ptcptg., ctf. 3	a9½	a9½
Chicago Railways, ptcptg., ctf. 4	a5¼	a5¼
Cincinnati Street Railway	a131	a131
Cleveland Railway	a104½	104½
Cleveland, Southwestern & Columbus Ry. (common)	*4¾	*4¾
Cleveland, Southwestern & Columbus Ry. (preferred)	*33	*33
Columbus Railway & Light Company	a55	a55
Columbus Railway (common)	a80	a80
Columbus Railway (preferred)	a94	a94
Dayton Street Railway (common)	a25	a25
Dayton Street Railway (preferred)	a100	a100
Denver & Northwestern Railway	*135	*135
Detroit United Railway	a70	a70
General Electric Company	a166¾	a167¼
Georgia Railway & Electric Company (common)	a176	a180
Georgia Railway & Electric Company (preferred)	a87½	a87¾
Interborough Metropolitan Company (common)	20⅝	20
Interborough Metropolitan Company (preferred)	60⅝	60
International Traction Co. 4% bonds, rcts	*75	*75
Indiana Union Traction Company	*10½	*10½
Kansas City Railway & Light Company (common)	a20	a20
Kansas City Railway & Light Company (preferred)	a50	a52
Lake Shore Electric Railway (common)	*6½	*6½
Lake Shore Electric Railway (1st preferred)	*90	*90
Lake Shore Electric Railway (2d preferred)	*22½	22½
Manhattan Railway	a138	a138
Massachusetts Electric Companies (common)	a22½	a21½
Massachusetts Electric Companies (preferred)	a96¼	a96¼
Milwaukee Electric Railway & Light (preferred)	*105	*105
Norfolk Railway & Light Company	27	27
North American Company	a79½	a79½
Northern Ohio Light & Traction Company (common)	a65	a70
Northern Ohio Light & Traction Company (preferred)	a105	a105
Philadelphia Company, Pittsburgh (preferred)	a54½	a54
Philadelphia Company, Pittsburgh (common)	a44	a44¼
Philadelphia Rapid Transit Company	a23⅛	a23⅛
Portland Railway, Light & Power Company	*71½	*71½
Public Service Corporation	a112	a112
Third Avenue Railway, New York	42	40⅞
Toledo Railways & Light Company	a10	a6
Twin City Rapid Transit Co., Minneapolis (common)	a105⅛	a105½
United Rys. & Electric Company (Baltimore)	*20½	*20½
United Rys. Inv. Co. (common)	a35	34
United Rys. Inv. Co. (preferred)	62¾	62½
Virginia Railway & Power Company (common)	a47½	a50
Virginia Railway & Power Company (preferred)	88½	*88½
Washington Ry. & Electric Company (common)	a90	a80⅞
Washington Ry. & Electric Company (preferred)	a95⅛	a96
West End Street Railway, Boston (common)	a86¼	a86
West End Street Railway, Boston (preferred)	a103	a102½
Westinghouse Elec & Mfg. Co.	a78½	a76
Westinghouse Elec. & Mfg. Co. (1st preferred)	a121⅞	a122½

*Last sale. aAsked.

American Light & Traction Company, New York, N. Y.—F. I. Brown and C. F. Jelliffe, have been elected directors of the American Light & Traction Company to succeed W. L. Bull and J. M. McCarthy.

Boston, Revere Beach & Lynn Railroad, Boston, Mass.—The stockholders of the Boston, Revere Beach & Lynn Railroad have approved the purchase of the Point Shirley Street Railway and have authorized an issue of 17,000 shares of additional stock of the company to provide funds to complete the purchase. The new stock will be offered at $110 a share to the present stockholders, in the ratio of one new share for every five now held.

Cairo Railway & Light System, Cairo, Ill.—The McKinley interests have purchased the property of the Mound City Water, Light, Power, Heat & Manufacturing Company, Mound City, and will operate the plant as part of the Cairo Railway & Light System, of which W. B. McKinley is president.

Carolina Power & Light Company, Raleigh, N. C.—The Carolina Power & Light Company has acquired the property of the Asheville Electric Company, which does the street railway, gas, electric light and power business in Asheville, N. C., and adjacent territory, and a new company, the Asheville Power & Light Company, has been incorporated, with a capital of $2,000,000, to operate the newly acquired properties. The new company has $1,000,000 of common stock and $1,000,000 of preferred stock. About $500,000 of the latter will be sold, and some bonds will be issued shortly. The change in ownership was effective April 1. The Carolina Power & Light Company placed its 30,000-hp hydroelectric station at Blewitts Falls in operation on April 1, and the plant is now supplying about 8000 hp to the Southern Power Company, and several thousand horse-power in addition to the Yadkin River Power Company. The energy delivered to the Southern Power Company is furnished under contract, there being no financial connection between this company and the Carolina Power & Light Company. The latter, however, owns the controlling interest in the Yadkin River Power Company. The Carolina Power & Light Company plans gradually to close down its steam stations and hold them in reserve.

Coney Island & Brooklyn Railroad, Brooklyn, N. Y.—The Coney Island & Brooklyn Railroad has obtained permission from the Public Service Commission of the First District of New York to expend $99,755 on replacements and betterments. The money will come out of a note issue for $500,000 already authorized by the commission.

Federal Light & Traction Company, New York, N. Y.—The Federal Light & Traction Company has sold to White, Weld & Company, New York, N. Y., $3,000,000 of first-lien 5 per cent sinking fund gold bonds which are part of an authorized issue of $50,000,000. The proceeds from the sale of these and $1,500,000 of 6 per cent debentures will be used to retire $2,000,000 of 6 per cent notes which mature on Feb. 15, 1913, already called for payment, and other floating indebtedness.

Indiana Union Traction Company, Anderson, Ind.—A. W. Brady, president of the Indiana Union Traction Company, has explained, in part as follows, the purpose of the proposed consolidation of the Indiana Union Traction Company and the Union Traction Company of Indiana, to be voted upon by the stockholders of the companies on April 25, 1912: "The only object sought to be gained by the consolidation of the two companies is to place the entire property in better position for its proper improvement and development, to the advantage alike of the public it serves and its owners. The difficulties of the situation arise from the lease of the Union Traction Company of Indiana to the Indiana Union Traction Company in 1903. Under this lease as modified in 1904 an annual rental payment of $75,000 must be made by the Indiana Union Traction Company to the Union Traction Company of Indiana whenever the gross annual receipts of the lessee with some exceptions amount to $1,800,000, together with an additional rental payment of 30 per cent of all additional receipts with the same exceptions. These rentals have been distributed as dividends among the stockholders of the Union Traction Company of Indiana. For the last few years improvements have cost the Indiana Union Traction Company more than

$100,000 each year. Those contemplated for this year will greatly exceed this amount. The immediate effect of a consolidation would be to merge the separate companies into one, as an incident to which the lease itself would be merged, thereby leaving the payment of dividends to be determined, not arbitrarily, whether business condition warranted or not, but according to the best interests of the company and its stockholders."

Indianapolis & Louisville Electric Railway, Scottsburg, Ind.—The Indianapolis & Louisvile Electric Railway, which took over the property of the Indianapolis & Louisville Traction Company following the recent sale under foreclosure, noted in the Electric Railway Journal of March 30, 1912, page 519, has elected the following officers: Jerome Hill, Pittsburgh, president; John E. Greeley, Louisville, vice-president and general manager; Charles C. Tennis, Pittsburgh, treasurer; Nathan G. Eyster, Pittsburgh, secretary. Mr. Greeley acted as receiver of the Indianapolis & Louisville Traction Company.

Indianapolis Traction & Terminal Company. Indianapolis, Ind.—A committee consisting of eight stockholders of the Indianapolis Street Railway, which is leased to the Indianapolis Traction & Terminal Company, is seeking proxies for use at the annual meeting of the company on April 10, 1912, to elect to the board of directors interests which they favor to represent the stock now owned in Indianapolis and by residents elsewhere in Indiana. The following statements appear in the appeal of the committee for proxies: "Should you favor the committee herein designated with your proxies, the commiteee proposes to elect a board of directors to represent the real owners of the property, which is now owned in Indiana. Of the $5,000,000 issue of stock of the Indianapolis Street Railway, more than $3,000,000 is owned by Indianians, who in the last few years bought the stock solely for investment. It is to protect this investment that we ask your proxy. The Indianapolis Street Railway is leased to the Indianapolis Traction & Terminal Company on the latter company's guarantee of a 6 per cent per annum dividend on the stock of the Indianapolis Street Railway. The lease also provides that the old Indianapolis Street Railway property shall be maintained in good condition, but stockholders are doubtless aware from the continual newspaper comment in Indianapolis that the Indianapolis Traction & Terminal Company is not complying with the terms of the lease in this respect. Without the slightest disparagement of the gentlemen who now constitute the board of directors of the Indianapolis Street Railway, it is sufficient to say that your own interests do not lie with any board elected by the people who have leased the street railway property."

International Traction Company, Buffalo, N. Y.—The committee of bondholders of the International Traction Company, of which Robert L. Fryer is chairman, has given notice that 99 per cent of the $18,355,000 of fifty-year 4 per cent collateral trust gold bonds of 1899 have been deposited under the reorganization agreement of June 21, 1910, but that owing to the unwillingness of the Public Service Commission of the Second District of New York to permit the capitalization called for by the modified plan, the committee has filed with J. P. Morgan & Company, New York, N. Y., the depositary, a substitute bondholders' plan dated March 22, 1912, which has already received the approval of owners of a large amount of the deposited bonds. The depositors are requested to further the reorganization by filing their assents to the substituted plan.

Lincoln (Neb.) Traction Company.—The Lincoln Traction Company has applied to the State Railway Commission for permission to issue preferred stock or bonds to the amount of $81,175 to pay for improvement and betterments which have already been made.

Monongahela Traction Company, Clarksburg, W. Va.—The Fidelity Trust Company, Baltimore, Md., will head a syndicate to underwrite $2,500,000 of general mortgage 5 per cent bonds of the Monongahela Traction Company to retire $1,000,000 of notes of the Fairmont & Clarksburg Traction Company and to provide funds to construct branch lines to Weston, W. Va. As stated in the Electric Railway Journal of March 23, 1912, page 479, the Monongahela Traction Company was organized to take over the property of the Fairmont & Clarksburg Traction Company, the Fairmont & Northern Traction Company, and the Clarksburg & Western Electric Railway.

Pine Bluff (Ark.) Company.—The Pine Bluff Company has been incorporated by the interests which recently negotiated the purchase of the property of the Citizens' Light & Transit Company, Pine Bluff, and will take over that property.

Portland Railway, Light & Power Company, Portland, Ore.—The property of the Mount Hood Railway & Power Company has been purchased in the interest of the Portland Railway, Light & Power Company.

Saginaw & Flint Railway, Saginaw, Mich.—The Commonwealth Power, Railway & Light Company, which controls the Saginaw-Bay City Railway, has purchased the Saginaw & Flint Railway, which connects Saginaw and Flint, and the Saginaw & Flint Railway will be operated in connection with the Saginaw-Bay City Railway. It is proposed to extend the Saginaw & Flint Railway to Bay City from Saginaw on the east side of the Saginaw River. New officers have been elected for the Saginaw & Flint Railway as follows: B. C. Cobb, president; J. A. Cleveland, vice-president; F. C. Potvin, secretary; A. B. Simoneau, treasurer; S. E. Wolff, assistant secretary and assistant treasurer; B. C. Cobb, J. C. Weadock, H. T. Wickes, J. A. Cleveland and J. F. Collins, directors.

United Properties Company, Oakland, Cal.—Mention was made in the Electric Railway Journal of March 30, 1912, page 519, of the organization of the San Francisco-Oakland Terminal Railways to take over the Oakland Traction Company, San Francisco, Oakland & San José Consolidated Railway, East Shore & Suburban Railway, the Sacramento Short Line Railway, San José Short Line Railway, Pacific Terminal Company and the California Railway. It has since been announced that the capital stock of the consolidated company is to be $28,175,000 in shares of $100 each, divided into first preferred stock, second preferred stock and common stock. It is intended to make a first and refunding mortgage for an amount sufficient to provide for the retirement at or before maturity of all existing bonds of the companies taken over and also for additions and improvements during a long term of years. The president of the new company will be F. M. Smith.

United Railways, St. Louis, Mo.—The United Railways has arranged with Fanshawe & Company, New York, N. Y., to extend the $1,813,000 of 5 per cent bonds of the Cass Avenue & Fair Grounds Railway, which mature on July 1, 1912, for a period of ten years, the interest rate to be reduced to 4½ per cent.

United Water, Light & Traction Company, Somerset, Ky.—The United Water, Light & Traction Company, Somerset, Ky., has passed under the control of the Insull interests of Chicago, and new officers have been elected as follows: M. J. Insull, New Albany, Ind., president; O. H. Waddle, Somerset, vice-president; Robert G. Gordon, Louisville, secretary, and J. L. Waddle, Somerset, general manager. Mr. Insull is general manager of the Louisville & Northern Railway & Lighting Company and the Louisville & Southern Indiana Traction Company.

Washington Railway & Electric Company, Washington, D. C.—The Washington Railway & Electric Company is offering holders of the $250,000 of 6 per cent bonds of the Brightwood Railway, which mature on Oct. 1, 1912, the right to exchange these bonds until May 1, 1912, for an equal amount of consolidated 4 per cent bonds of the Washington & Electric Company, due on Dec. 1, 1951, and 15 per cent in cash.

Winnipeg (Man.) Electric Railway.—Shareholders of the Winnipeg Electric Railway of record of March 30, 1912, have the right to subscribe at par on or before April 15, 1912, for $3,000,000 of the $4,000,000 of new stock of the Winnipeg Electric Railway, authorized on Feb. 14, 1912, their subscriptions not to exceed 50 per cent of their respective holdings.

Youngstown & Ohio River Railroad, Youngstown, Ohio.—The Youngstown & Ohio River Railroad paid a quarterly dividend of 1⅛ per cent on the $1,000,000 of 5 per cent preferred stock on March 30, 1912. This compares with 1 per cent paid by the company in January and October, 1911, and three-quarters of 1 per cent paid quarterly from October, 1910, to July, 1911, inclusive.

Dividends Declared

Rome Railway & Light Company, Rome, Ga., quarterly, 1½ per cent.

Scioto Valley Traction Company, Columbus, Ohio, quarterly, 1¼ per cent, first preferred and preferred.

Springfield & Xenia Railway, Springfield, Ohio, quarterly, 1½ per cent.

Stark Electric Railroad, Alliance, Ohio, quarterly, ¾ of 1 per cent.

Terre Haute, Indianapolis & Eastern Traction Company, Indianapolis, Ind., quarterly, $1.25, preferred.

Union Railway, Gas & Electric Company, Rockford, Ill., quarterly, 1½ per cent, preferred.

United Light & Railways Company, Grand Rapids, Mich., quarterly, 1½ per cent, first preferred; ¾ of 1 per cent, second preferred.

Utica & Mohawk Valley Railway, Utica, N. Y., quarterly, 1¼ per cent, preferred; quarterly, 1 per cent, common.

Virginia Railway & Power Company, Richmond, Va., 1 per cent, common.

Western Ohio Railway Lima, Ohio, quarterly, 1¾ per cent, first preferred; quarterly, 1½ per cent, second preferred.

Wheeling (W. Va.) Traction Company, quarterly, 1¼ per cent.

Winnipeg (Man.) Electric Railway, quarterly, 3 per cent.

Youngstown & Ohio River Railroad, Leetonia, Ohio, quarterly, 1⅛ per cent, preferred.

ELECTRIC RAILWAY MONTHLY EARNINGS.

AURORA, ELGIN & CHICAGO RAILROAD

Period.			Gross Earnings.	Operating Expenses.	Net Earnings.	Fixed Charges.	Net Surplus.
1 m.,	Feb.	'12	$120,641	$76,693	$43,348	$36,935	$7,013
1 "	"	'11	112,296	75,912	36,385	35,834	551

EAST ST. LOUIS & SUBURBAN RAILWAY

1 m.,	Feb.	'12	$185,800	$100,155	$856,351	.....	.....
1 "	"	'11	168,680	92,970	75,710	.....	.....
2 "	"	'12	376,844	202,338	174,507	.....	.....
2 "	"	'11	357,404	189,609	167,795	.....	.....

HUDSON & MANHATTAN RAILROAD

1 m.,	Feb.	'12	$434,323	$185,508	$248,815	$241,145	$10,670

HOUGHTON COUNTY TRACTION COMPANY, MICH.

1m.	Jan.,	'12	$22,125	$18,345	$3,781	$5,227	$1,446
1 "	"	'11	23,256	17,310	5,946	5,260	686

JACKSONVILLE (FLA.) TRACTION COMPANY

1m.	Jan.,	'12	$49,878	$31,948	$17,930	$9,275	$8,656
1 "	"	'11	52,765	30,958	21,808	6,904	14,904

LEWISTON, AUGUSTA & WATERVILLE STREET RAILWAY, LEWISTON, MAINE

1m.	Feb.,	'12	$37,213	*$31,356	$5,857	$14,443	$8,584
1 "	"	'11	31,096	*27,661	3,435	13,187	9,752
8 "	"	'12	412,662	*258,490	154,172	115,594	38,578
8 "	"	'11	359,232	*224,787	134,445	105,033	29,412

MONTREAL STREET RAILWAY

1 m.,	Feb.	'12	$393,996	$270,124	$123,872	$46,941	$76,931
1 "	"	'11	330,738	227,605	103,133	41,974	61,159

NORTHERN OHIO TRACTION & LIGHT COMPANY.

1 m.,	Feb.	'12	$198,210	$119,556	$78,654	$43,821	$34,833
1 "	"	'11	172,413	104,869	67,545	44,357	23,188
2 "	"	'12	407,598	242,091	165,507	87,646	77,862
2 "	"	'11	358,685	211,772	146,912	88,786	58,126

PENSACOLA (FLA.) ELECTRIC COMPANY

1m.	Jan.,	'12	$22,262	$15,418	$6,843	$6,377	$466
1 "	"	'11	22,369	14,118	8,251	5,291	2,960

ST. JOSEPH RAILWAY, LIGHT, HEAT & POWER COMPANY, ST. JOSEPH, MO.

1m.	Jan.,	'12	$91,701	*$51,845	$39,856	$19,710	$20,146
1 "	"	'11	83,126	*48,635	34,491	19,276	15,215
2 "	"	'12	194,242	*107,825	86,417	39,335	47,082
2 "	"	'11	174,114	*99,253	74,253	38,569	35,684

TAMPA (FLA) ELECTRIC COMPANY.

1m.	Jan.,	'12	$60,752	$32,448	$28,304	$4,551	$23,754
1 "	"	'11	53,224	30,176	23,048	4,583	18,466

TWIN CITY RAPID TRANSIT COMPANY

1 m.,	Feb.	'12	$616,536	$340,750	$275,786	$143,079	$132,707
1 "	"	'11	576,935	305,485	271,450	140,079	131,371
2 "	"	'12	1,243,449	1,252,045	705,683	546,361	283,158
2 "	"	'11	1,181,783	1,195,874	642,279	553,595	280,158

UNION RAILWAY, GAS & ELECTRIC COMPANY, ROCKFORD, ILL.

1m.	Jan.,	'12	$313,721	*$184,984	$128,737	$65,583	$63,154
1 "	"	'11	276,382	*162,373	114,009	59,395	54,614

*Includes taxes.

Traffic and Transportation

Decision in New York Fare Complaint Case

In an order dated Sept. 20, 1909, in the matter of the complaint of C. E. Wheaton the Elmira, Corning & Waverly Railway was directed by the Public Service Commission of the Second District of New York to establish and keep in force for a period of at least one year a fare of not more than 5 cents for the transportation of passengers over its line between Waverly and Holbert's Crossing and intermediate points, the fare theretofore charged having been 10 cents per passenger. In view of the possibility that under the operation of the order the gross revenue of the company might be materially diminished, the effectiveness of the order of the commission was limited to one year, with the right remaining in respondent to apply for a modification or abrogation of the order at any time. It was stated in the opinion:

"When respondent's service shall be extended into the center of Waverly [as was then contemplated] it is possible that the fare limit at Holbert's for Waverly traffic should be brought eastward [or toward Waverly] a short distance, but that is a question on which no opinion can now be expressed."

The 5-cent fare was established and put in effect on Oct. 4, 1909. Effective on March 15, 1911, some time after the one year period had expired, the company increased its fare between Waverly and Holbert's Crossing to 10 cents per passenger, thereby restoring the fare originally complained of. At the same time the company re-established its 5-cent fare limit point from Waverly at Wilson's Crossing, which is intermediate to Waverly and Holbert's Crossing and nearer Waverly by 6741 ft., or 1.27 miles, and which was the first 5-cent fare point out of Waverly when the Wheaton complaint was filed.

Complaint about the re-establishment of the 10-cent fare was subsequently made to the commission, and the company agreed to put in effect a monthly school commutation ticket for children. In concluding its opinion the commission says:

"The decision in the former case was based upon the conditions then existing. The opinion rendered in that case expressly reserved the extension of line into Waverly as constituting a new and material element, and the fare reduction requirement was limited to one year. The former 10-cent fare from Holbert's to the edge of Waverly yielded 3.18 cents per mile. The present 10-cent fare over the line as extended to about the center of Waverly yields 2.58 cents per mile. A 5-cent fare for the present distance would yield 1.43 cents per mile. Taking no account of the 1¼ cents paid for the trackage use and power of the connecting line in Waverly, we are not satisfied that the traffic involved or the financial condition of the respondent company warrants an order reducing the fare to the 5-cent basis.

"The original complaint resulted from the refusal of the company to make a school commutation fare of 5 cents. The law has since been amended, giving the commission authority to order a carrier to publish and charge reasonable commutation rates for scholars and others. At the hearing upon this complaint respondent, by its general manager, offered in settlement of the controversy to put in effect a monthly school commutation ticket for children certified by the school trustees in an application for ticket as attending school in the village of Waverly, limited to cars arriving in Waverly between 8 a.m. and 9 a.m. and returning from Waverly between 3 p.m. and 5 p.m., for a fare of 5 cents per ride. This would be the regular forty-six-ride monthly school ticket limited to scholars not over eighteen years of age. Under all the circumstances we think this should constitute the disposition of the case. Respondent will be notified that upon the establishment of such school commutation the complaint herein will be dismissed."

Through Freight Urged Between Louisville and Indianapolis.—The Louisville (Ky.) Commercial Club has undertaken a campaign in favor of through freight service on the electric railways between Louisville and Indianapolis, and

a meeting of business men is to be held under the auspices of the club to formulate plans for establishing the service.

Lake Shore Electric Railway to Increase Wages.—The wages of all employees of the Lake Shore Electric Railway, Cleveland, Ohio, will be advanced on May 1, 1912. Motormen and conductors in each of the several classes into which the men are divided will receive an increase of 2 cents an hour. This will make the schedule 29 cents an hour for men who have been in the service five years, 27 cents an hour for men in the service four years, 25 cents for three years, 23 cents for two years, and 21 cents for beginners. Engineers and substation employees will receive $5 per month in addition to their present wages.

Placing Wires Underground in Hartford.—The Public Utilities Commission of Connecticut ordered a hearing to be held on March 26, 1912, on the petition of the Connecticut Company for the approval of its method of placing electric feed wires underground in Hartford. The petition of the company was in response to an order of the street board of Hartford passed on Jan. 11, 1911, instructing the company to place the wires underground in Main Street from Pearl Street to Sheldon Street. The company claimed that the proper and efficient operation of its lines would be prevented if the order of the street board was carried out. The company purposes wholly to remove the feed wires from the sections described by the street board and has submitted a plan under which the work will be carried out.

Extensions Frequently Unprofitable.—H. B. Zimmerman, general manager of the Gray's Harbor Railway & Light Company, Aberdeen, Wash., recently made the following statement in regard to the inability of the company to meet the demands which are made for the construction of extensions: "All the money taken in by a public corporation must come out of the people's pockets. Suppose some man with ten lots on the edge of the city starts a demand for extension of car service to his property. Suppose the service is given to him, and the business which results does not compensate the company, or results in a loss. The owner of those ten lots gains personally by having the service extended, but the company does not, and the public from whom the company must make its earnings suffers from the injustice also. Many people seem to think that a street railway has nothing to do but count enormous profits extracted from the poor public. As a matter of fact, we do not make our profits from side lines. Our percentage is very low, and on some of the lines we are actually losing money. The Gray's Harbor Railway & Light Company tries to be as accommodating as possible. When people ask for extensions of service we will give them whenever we can see the slightest show to break even, let alone make a profit. We are looking out for future business. It is, however, unfair to ask the company to give service where business will not justify the expenditure."

Express Franchise in Syracuse.—A new franchise giving the Syracuse (N. Y.) Rapid Transit Railway the right to operate express cars under limitations favored by the Aldermen has been presented to the Common Council of Syracuse. The franchise is for twenty-five years, to be divided into five-year periods. During the first five-year period the company must pay to the city 3 per cent of its gross receipts from the express business. The return to the city for the other five-year periods is made a subject of future negotiation. In case of a disagreement the adjustment is to be left to the Public Service Commission. Five divisions of the system are recognized and to insure continued service the franchise requires that one car a day shall be run over each division in each direction except Sundays, when no express cars are to be operated. Another condition is that the express cars must not be run so as to interfere with passenger traffic, and no express cars are to be run from 6.30 a.m. to 8.30 a.m. and from 5.30 p.m. to 7.30 p.m. In case of a wilful violation of the franchise the Common Council, with the consent of the Board of Estimate and Apportionment, reserves the power to revoke the rights granted. The company is to open all its books and records which pertain to the express business for the inspection of the Public Service Commission or its accountants so that new terms can be reached in regard to the payments to be made to the city from the gross receipts. The company waives its right to appeal from a decision of the commission.

Personal Mention

Mr. R. A. Barnett has been appointed superintendent of transportation on the lines of the Michigan United Traction Company at Owosso, Mich.

Mr. F. M. Farley has been appointed superintendent of track, roadway and buildings of the Michigan United Traction Company, Jackson, Mich.

Mr. F. W. Haak has been appointed electrical superintendent of the Michigan United Traction Company, with headquarters at Jackson, Mich.

Mr. O. H. Waddle, formerly president of the United Water, Light & Traction Company, Somerset, Ky., has been elected vice-president of the company.

Mr. R. T. Senter, formerly master mechanic of the International Railway, Buffalo, N. Y., has been appointed superintendent of rolling stock and buildings of the Philadelphia (Pa.) Rapid Transit Company to succeed Mr. Henry Branson.

Mr. Dean McLaughlin has been appointed superintendent of transportation of the lines of the Michigan United Traction Company at Jackson, Mich. Mr. McLaughlin was formerly connected with the Toledo Railways & Light Company.

Mr. M. J. Insull, general manager of the Louisville & Southern Indiana Traction Company and the Louisville & Northern Railway & Lighting Company, New Albany, Ind., has been elected president of the United Water, Light & Traction Company, Somerset, Ky.

Mr. C. H. Smith has been appointed superintendent of transportation of the lines of the Michigan United Traction Company at Kalamazoo, Mich. Mr. Smith was formerly assistant to Mr. B. F. O'Mara, resident manager in charge of the lines of the Michigan United Railways at Kalamazoo.

Mr. E. M. Raver has been appointed superintendent of transportation of the lines of the Michigan United Traction Company at Battle Creek, Mich. Mr. Raver was formerly assistant to Mr. J. M. Bramlette, resigned, who was resident manager of the lines of the company in Jackson, Mich.

Mr. Fred C. Hornstein, formerly with the Westinghouse Electric & Manufacturing Company and the Indianapolis Brass Company, has been appointed chief engineer of the Tarentum, Breckinridge & Butler Street Railway, a road now under construction between Tarentum and Birdville, Pa.

Mr. G. A. Harvey, formerly electrical engineer of the International Railway, Buffalo, N. Y., has been appointed electrical engineer of the Philadelphia (Pa.) Rapid Transit Company to succeed Mr. Charles Hewitt, whose resignation as superintendent of motive power of the company is referred to elsewhere in this column.

Mr. L. E. Lynde has resigned as superintendent of the Manchester (N. H.) Street Railway. Mr. Lynde has been connected with the company since May 15, 1910. He was formerly superintendent of the electric railway between Amesbury and Haverhill, Mass., operated by the New Hampshire Electric Railways.

Mr. W. E. Maloy has been appointed superintendent of transportation of the lines of the Michigan United Traction Company at Lansing, Mich., and also the St. John and Owosso interurban divisions of the company. Mr. Maloy was formerly connected with the Toledo Railways & Light Company, Toledo, Ohio, for fourteen years.

Mr. Hugh K. Sherman, formerly assistant purchasing agent of the Toledo Railways & Light Company, Toledo, Ohio, has been appointed purchasing agent of the Michigan United Traction Company with headquarters at Jackson, Mich. Mr. Sherman succeeds Mr. J. E. Terrel, who has been acting purchasing agent of the company.

Mr. C. N. Jellife, secretary of the American Light & Traction Company, New York, N Y., has also been elected treasurer of the company to succeed Mr. James M. McCarthy, who has resigned as vice-president and treasurer of the company. A successor to Mr. McCarthy as vice-president of the company has not yet been elected.

Mr. R. C. Taylor, who has been master mechanic of the Chicago, Ottawa & Peoria Railway, Ottawa, Ill., has been

appointed superintendent of equipment of the Michigan United Traction Company, with headquarters at Albion. Before becoming connected with the Chicago, Ottawa & Peoria Railway, Mr. Taylor was in charge of the outside shops of the Illinois Traction System and previous to that was engineer of maintenance and equipment of the company and master mechanic in charge of the shops at Granite City, Ill. Mr. Taylor also served as superintendent of motive power of the Indiana Union Traction Company, Anderson, Ind., and previously was connected with the mechanical department of the Twin City Rapid Transit Company, Minneapolis, Minn., and was superintendent of rolling stock equipment of the Brooklyn (N. Y.) Rapid Transit Company. He has been engaged in electric railway work about seventeen years.

Mr. George V. S. Williams, Brooklyn, N. Y., on March 29, 1912, was named by Governor Dix as a member of the Public Service Commission of the First District of New York to succeed Mr. William McCarroll, whose term of office has expired. The nomination was subsequently confirmed by the Senate. Mr. Williams was born in Sullivan County, N. Y. He was graduated from the Albany Law School and was admitted to the bar. He entered the office of Morris & Whitehouse, counsel for the Brooklyn City Railway, and when Sheehan & Collin took up the work of the railroads he went with that firm and continued with it until 1903. Then he formed a partnership with the late Abraham H. Dailey. Mr. Williams was appointed counsel for the New York State Conservation Commission by the Governor a year ago.

Mr. C. G. Taylor, superintendent of the Cleveland, Southwestern & Columbus Railway, Norwalk, Ohio, has been appointed general superintendent of the Sandusky, Norwalk & Mansfield Electric Railway, Norwalk, Ohio. Mr. Taylor will have direct charge of the road, the equipment, the running of the cars and the affairs of the employees. Mr. Taylor has had twenty years' experience in electric railway work. He was in the general offices of the Cleveland, Southwestern & Columbus Railway in Cleveland for seven years before being appointed superintendent of the company at Norwalk two years ago. Mr. Taylor will continue to supervise the operation of the electric light plant at Norwalk, which is the property of the Cleveland, Southwestern & Columbus Railway, and will retain his title as superintendent of the Cleveland, Southwestern & Columbus Railway, which operates 220 miles of line.

Mr. Charles Hewitt has resigned as superintendent of motive power of the Philadelphia (Pa.) Rapid Transit Company, with which he has been connected since 1894. Mr. Hewitt has had an unusually broad experience in designing, constructing and operating electrical generation and distribution systems, including both railway and power work. He began his career with the Edison Company, Paterson, N. J., which he organized in 1887. Subsequently he spent five years with the Sprague Electric Railway & Motor Company and its successors, the Edison General Electric Company and the General Electric Company. His first service in Philadelphia was with the Electric Traction Company and the Union Traction Company as electrical engineer. Two years after entering the employ of these companies he was made superintendent of motive power, and he has recently had under his direction fourteen power stations, twelve substations and 700 employees. He is a full member of the American Institute of Electrical Engineers, a member of the American Electric Railway Engineering Association and is first vice-president of the Engineers' Club in Philadelphia. He served two years as a member of the joint committee on shop accounting of the American Electric Railway Association and one year as a member of the committee on standards of that association. From time to time Mr. Hewitt has presented papers before engineering societies and has contributed to the technical press on subjects which have come within the scope of his personal work.

OBITUARY

Charles N. Mann, Philadelphia, Pa., a member of the Pennsylvania State Railroad Commission, is dead. Mr. Mann was seventy-two years old. He was a lawyer and had been a member of the railroad commission since it was created.

Construction News

Construction News Notes are classified under each heading alphabetically by States.

An asterisk (*) indicates a project not previously reported.

RECENT INCORPORATIONS

***Petaluma & Coast Railway, Petaluma, Cal.**—Application for a charter has been made in California by this company to build an 18-mile interurban railway from Liberty to Bloomfield, and thence to a point on the cost near Bodega, all in Sonoma County. Capital stock, $250,000. Directors: J. E. Alexander, H. Levy, A. F. Hoehmer and D. S. Hyde, San Francisco, and W. P. Ferguson, Santa Rosa.

Riverside-Redlands Interurban Railway, Riverside, Cal.—Application for a charter has been made in California by this company to build an electric railway near Redlands. Capital stock, $2,500,000. Directors: William S. Ploubet and Maurice Salzman, Los Angeles, and F. E. Dinsmore, Charles E. Johnson and R. E. Smith, Riverside.

***Sacramento (Cal.) Interurban Railway.**—Application for a charter has been made in California by this company to build an electric railway to connect Sacramento, Fair Oaks, Orangevale and Roseville, a distance of 13 miles. Capital stock, $500,000. Directors: M. N. Williamson, Marshal Diggs, Ray C. Waring, A. D. Kildahl, Sacramento, and Charles E. Hollister and James F. Elliott, Courtland.

***Central California Railroad, San Francisco, Cal.**—Incorporated in California to build an electric railway, which ultimately is to be an extension of the San Juan Pacific Electric Railway to Fresno. The immediate plan of this company is to build westerly from Hollister to San Juan, Chittenden and Watsonville. Capital stock, $2,000,000.

***Hutchinson & Northern Railway, Hutchinson, Kan.**—Incorporated in Kansas to build a 150-mile electric or steam railway from Hutchinson, north through Harvey, Reno, McPherson, Dickinson, Clay and Washington Counties to Fairbury, Neb. It will connect with the St. Louis & San Francisco Railroad, Union Pacific Railroad, Chicago, Burlington & Quincy Railroad and Missouri Pacific Railway lines in the northern part of the State. The line north from Hutchinson will be built this summer. Incorporators: W. S. Thompson, C. O. Hitchcock, L. S. Davis, L. A. Bunker and F. E. Pearl, all of Hutchinson.

***Errol Heights Railway, Portland, Ore.**—Application for a charter has been made by this company in Maine to build an electric railway from the present line of the Portland Railway, Light & Power Company on Woodstock Avenue, Portland, to a point one-third of a mile south of the city limits on the Milwaukee road. Capital stock, $20,000. Incorporators: Fred A. Jacobs, C. W. Hodson and G. M. Shrock.

***Westernport & Keyser Electric Railway, Westernport, Md.**—Application for a charter has been made in Maryland by this company to build an electric railway from the terminus of the Cumberland & Westernport Electric Railway, Westernport, to McCoole and thence across a bridge over the Potomac River to the southern boundary line between Maryland and West Virginia. Incorporators: Andrew Ramsay, Hazelhurst Sprigg and James P. Gaffney, of Allegany County, and Frank C. Reynolds and George C. Dixon, of Mineral County.

***Monongahela-Bentleyville Street Railway, Monongahela, Pa.**—Application for a charter has been made by this company to build an electric railway between the city line of Monongahela and the borough line of Bentleyville. Incorporators: U. W. Tinker, George T. Smith, C. R. Turton, F. J. Taylor and S. M. Miller.

***Westtown Electric Railway, West Chester, Pa.**—Chartered in Pennsylvania to build an electric railway, presumably between Media and West Chester. Capital stock, $5,000. Incorporators: Edward E. Mandeville, Devon; Matthew Maury and Austin G. Maury.

***Fort Worth, Mineral Wells & Northwestern Railway, Fort Worth, Tex.**—Incorporated in Texas to build an electric or gasoline motor railway from Fort Worth to Mineral Wells and thence in a northwesterly direction to Roswell,

N. M. Principal office: Fort Worth. Capital stock, $100,000. Incorporators: James B. Watkins, Little Rock, Ark.; J. S. Handford and Paul Hurley, Fort Worth.

FRANCHISES

Mobile, Ala.—The Mobile Light & Railroad Company has asked the City Commissioners for a franchise on Lexington Avenue between Spring Hill Avenue and Davis Avenue in Mobile.

Los Angeles, Cal.—The Pacific Electric Railway has asked the City Council for a franchise on San Pedro Street in Los Angeles.

Redwood City, Cal.—The Redwood City Railway has asked the Town Council for a franchise for a 6-mile electric railway to extend from the waterfront to the foothills west of Redwood City. George A. Merrill is interested. [E. R. J., April 14, '11.]

Richmond, Cal.—The San Francisco, Oakland & San José Railway, Oakland, has received a franchise from the Board of County Supervisors for 5000 ft. in Contra Costa County, from the Alameda County line toward Richmond.

Seabreeze, Fla.—The East Florida Traction Company has received a franchise from the Council in Seabreeze. Michael Scholtz is interested. [E. R. J., March 16, '12.]

Chicago, Ill.—The Chicago Railways has advertised an extension of its Armitage Avenue line from Milwaukee Avenue to Elston Avenue, which will include approximately 1⅛ miles of double track. An ordinance has been submitted to the City Council and will be acted on as soon as the majority of the frontage has been secured.

Henderson, Ky.—The Evansville, Henderson & Owensboro Railway has purchased a franchise offered by the city of Henderson to construct an interurban line at the northern limits of the city. The franchise gives the purchaser the right to contract with the Henderson Traction Company for the use of its tracks.

Brooklyn, N. Y.—The Coney Island & Brooklyn Railroad has petitioned the Board of Estimate for a franchise to construct a surface railway from Franklin and Atlantic Avenues along Atlantic Avenue to Fourth Avenue, Brooklyn. The company has also asked for permission to construct a railway connecting its existing tracks at Ninth Street and Fourth Avenue, along Fourth Avenue to Atlantic Avenue, in Brooklyn, and along Fourth Avenue to Flatbush Avenue to Ashland Place to Fulton Street and to DeKalb Avenue.

Irondequoit, N. Y.—The New York State Railways, Rochester, has received a franchise from the Town Board of Irondequoit to double track its lines on Ridge road.

Pelham, N. Y.—The Union Railway, New York, has received authority from the Assembly and the Board of Estimate to extend its tracks through the Pelham Bay Park.

Schenectady, N. Y.—The Schenectady Railway has asked the Common Council for a franchise to extend double tracks to Rugby Road and Union and Wendall Avenues in Schenectady.

Watertown, N. Y.—The Black River Traction Company, Watertown, will ask the Common Council for a franchise to double-track State Street in Watertown.

McKeesport, Pa.—An ordinance granting the McKeesport, Clairton & Westmoreland Railway the right to construct a railway along Water Street was repealed in the Council on March 11. The franchise was granted eight years ago to a number of prominent McKeesport men, but work was never started.

Pittsburgh, Pa.—The Pittsburgh Railways has received a ten-year franchise from the City Council in Pittsburgh to extend its line on Diamond Street and on other streets in Pittsburgh.

***Florence, S. C.**—J. C. Williamson, J. W. McCown and W. R. Barringer have asked the City Council for a franchise to build a street railway in Florence. Their purpose is to form a stock company with a capital stock of $25,000, build several miles of track in Florence and operate storage battery cars.

***Dallas, Tex.**—E. P. Turner, Dallas, has asked the Board of Commissioners for a franchise along certain streets in Dallas.

***Fort Worth, Tex.**—W. G. Newby, L. R. Scarborough, H. C. McCart, M. S. Blanton, C. R. Keith and others have asked the City Council for a twenty-five-year franchise to build an electric railway to connect with the Summit Avenue line in Fort Worth and extend west to the city limits. From that point on to the seminary a franchise will be asked of the County Commission.

TRACK AND ROADWAY

Noccalula Railway, Light & Power Company, Gadsden, Ala.—It is reported that work will soon be begun by this company on its 3½-mile electric railway from Gadsden to Noccalula Falls. Louis Hart, Gadsden, is interested. [E. R. J., June 18, '10.]

Mobile (Ala.) Interurban Motor Railway.—Surveys are being made by George H. Clark, Birmingham, for this company for its 2-mile electric railway between Springhill and Pinehurst. C. C. Meecham, Mobile, president. [E. R. J., Oct. 21, '11.]

Mobile (Ala.) West Shore Traction Company.—Right-of-way and financial backing are being secured by this company and construction will be begun within the next few weeks on its electric railway between Mobile, Alabama Port, Coden, Bayou la Batre and Pascagoula, Miss. H. Austell, Mobile, president. [E. R. J., Jan. 20, '12.]

Alberta Electric Railway, Calgary, Alta.—Plans are being considered by this company to build a line from Calgary to Macleod, via Gladys, Thigh Hill, Little Boy and Elinor. From Macleod the line will proceed to Ewelm and Pincher Creek. E. P. Newhall, general manager.

Arkansas Valley Interurban Railway, Little Rock, Ark.—Surveys have been begun by this company on the extension from Newton to Goessel, Canton, McPherson and possibly to Roxbury. As soon as the surveys north of Newton are completed surveys will be started southward out of Wichita on two lines. One of these will be east of the Arkansas River toward Rose Hill and Douglas, while the other will be west of the Arkansas River toward Belle Plaine.

British Columbia Electric Railway, Vancouver, B. C.—Work has been begun by this company on the 23-mile extension on Vancouver Island, from Victoria northerly through the Saanich peninsula, to Deep Cove, and a branch will be built to Union Bay, where a wharf is to be constructed. Moore & Pethick have the contract for grading 18 miles.

San Francisco, Napa & Calistoga Railway, Napa, Cal.—Right-of-way has been secured, material is on hand and construction will soon be begun on this company's extension from St. Helena to Calistoga, via the Napa Valley.

United Railroads, San Francisco, Cal.—Work has been begun by this company on the extension of its Parnassus Avenue line into the Sunset district, the contract for the work having been entered into by the San Francisco Electric Railways, from which the United Railroads leases the line when completed.

Idaho Falls (Idaho) Electric Railway.—Right-of-way has been obtained and construction will soon be begun by this company on its 40-mile line between Idaho Falls, Lincoln, Ammon, Iona and Heise. H. S. Sewell, Idaho Falls, secretary. [E. R. J., Feb. 17, '12.]

Fort Wayne & Northern Indiana Traction Company, Fort Wayne, Ind.—Extensive improvements will be made by this company on its lines in Fort Wayne during the next six months. The company expects to rebuild its Broadway line and the Calhoun Street tracks will be replaced. The Bloomingdale lines will also be improved this fall.

Terre Haute, Indianapolis & Eastern Traction Company, Indianapolis, Ind.—It is reported that this company will build an extension to Rockville, a distance of 44 miles, if the citizens along the route will subscribe 20 per cent of $750,000, the amount required to build the line, as a bonus.

Chicago, South Bend & Northern Indiana Railway, South Bend, Ind.—A belt line to connect with the Notre Dame line will be built by this company in South Bend within the next few months.

Des Moines & Red Oak Railway, Des Moines, Ia.—Plans are under way by this company to begin work in the near future on its 100-mile electric railway between Des Moines

and Red Oak, via Greenfield and Winterset. F. George C. Boileau, Red Oak, is interested. [E. R. J., May 21, '10.]

Union Traction Company, Coffeyville, Kan.—This company has placed orders for rails, ties, etc., for the extension from Cherryvale to Parsons.

***Custer, Ky.**—Alfred Taylor, Custer, Ky., is in charge of plans for the construction of a line from Custer to Cloverport, via Garfield, Harned, Hardinsburg and Cloverport, and is intended ultimately to reach Elizabethtown and Louisville.

***New Iberia & Lake Charles Electric Railroad, Abbeville, La.**—This company plans to build an interurban railway from New Iberia to Lake Charles, via Abbeville, St. Martinville, Breaux Bridge, Lafayette, Broussard and Youngsville. It is planned to begin work within the next two months on the section between New Iberia and St. Martinville.

***Suburban Electric Company, Baton Rogue, La.**—This company has been organized to take over the franchise for an electric railway from the business district of Baton Rogue into north and south Baton Rogue, which was asked from the City Council by the local group of business men last week. Among the organizers of the company, which has an authorized capital of $250,000, are S. J. Gianelloni, president; N. S. Dougherty, C. H. Dameron, Henry Y. Ronaldson and J. Allen Dougherty.

***St. Louis & St. Libory Railroad, St. Louis, Mo.**—The right-of-way and franchises of this company were sold at a master in chancery's sale in Belleville several days ago to C. C. Hutchmacher of Grand Chain, Ill., for $25,000. The roadbed has been graded for 14 miles and several bridges have been built, the largest being across the Kaskaskia River at Fayetteville. The late Edward L. Thomas of Belleville was the promoter of the road, which he intended as an outlet for coal fields that he expected to develop in the southeastern part of St. Clair County. The right-of-way starts at St. Libory, passes through Fayetteville and ends near Lementon, on the Illinois Central Railroad.

Stark Electric Railroad, Alliance, Ohio.—Arrangements have been completed and construction will soon be begun by this company to build from the city limits of Alliance to the city limits of Akron, a distance of 23 miles.

Niagara, St. Catharines & Toronto Railway, St. Catharines, Ont.—This company has applied to the department of railways and canals for permission to erect a bridge over the canal at Port Colborne. This is the first step toward the construction of its new line from Port Colborne to Fort Erie, Bridgeburg and Crystal Beach.

Oregon Electric Railway, Portland, Ore.—This company has awarded contracts for the construction of three crossings on its extension from Salem to Eugene to the Union Bridge & Construction Company. The principal structure will span the Willamette River at Harrisburg and the second will be across the Santiam River.

***Skippack, Pa.**—James M. Smith, Perkiomenville, has been awarded a contract for grading and poles for an electric railway from Skippack to Farleysville.

Tioga Traction Company, Wellsboro, Pa.—It is reported that this company has secured financial backing and will soon begin the construction of its line between Wellsboro and Mansfield. George F. Keagle, Avis, general manager. [E. R. J., April 8, '11.]

York (Pa.) Railways.—This company has been asked to consider plans to build an 8-mile extension from York to East Berlin, via Admire, Bigmount, Swam and Weigelstown. Surveys over this route were made by the company several years ago.

Chattanooga (Tenn.) Traction Company.—This company has awarded a contract for grading its line from Walden's ridge to Signal Point to the Noll Construction Company. The railway will connect Dayton and Cleveland, Tenn., and Dalton, Ga., out of Chattanooga. C. E. James, is interested. [E. R. J., Mar. 9, '12.]

***Corpus Christi, Tex.**—Citizens of Corpus Christi are preparing plans to build a 6-mile electric railway from Corpus Christi southeast around the bay front to Ward's Island. The project is backed by local capital.

Ogden (Utah) Rapid Transit Company.—Work will soon be begun by this company on several extensions in Ogden.

Chicago & Wisconsin Valley Railway, Madison, Wis.—Work will be resumed about April 15 by this company on the new Madison-Portage and Madison-Prairie du Sac lines. At the present time lines have been extended to the city limits of Madison and Portage. This company has divided the work into six sections, including lines from Madison to Portage, with branch lines; Middleton Junction to Prairie du Sac; Madison to Janesville; Portage to Stevens Point; Stevens Point to Wausau and Wausau to Merrill. Allen T. Russell, Chicago, general manager. [E. R. J., Feb. 3, '12.]

SHOPS AND BUILDINGS

People's Traction Company, Galesburg, Ill.—Plans and specifications have been completed by this company for a new terminal passenger and freight depot to be located at the intersection of Prairie Street and Tompkins Street in Galesburg.

Oshawa (Ont.) Railway.—On Mar. 29 this company's carhouse and office building in Oshawa were destroyed by fire. Five cars and all the contents of the workshops were also destroyed. The loss is estimated to be about $20,000.

Toronto (Ont.) Railway.—This company will rebuild at once its carhouse on King Street on the Don Esplanade in Toronto, which was recently destroyed by fire. The new structure will be of brick and stone similar to the company's present Lansdowne Avenue carhouse.

Columbia Railway, Gas & Electric Company, Columbia, S. C.—A new carhouse will be built by this company just south of the present carhouse near the corner of Main Street and Rice Street in Columbia. The cost will be about $75,000.

Nashville-Gallatin Interurban Railway, Nashville, Tenn.—Plans are being made by this company to build its passenger station on West Main Street in Gallatin.

Virginia Railway & Power Company, Richmond, Va.—This company has awarded the contract for the construction of its new twelve-story office building at the corner of Seventh Street and Franklin Street in Richmond to the John T. Wilson Company, Inc., of Richmond. The structure will be 50 ft. x 110 ft., and of stone, brick, terra cotta and steel construction. [E. R. J., Jan. 13, '12.]

POWER HOUSES AND SUBSTATIONS

British Columbia Electric Railway, Vancouver, B. C.—This company has prepared plans for a new substation on Earl's Road, South Vancouver, for the regulation of its light and power service in that district as well as on the Westminster interurban line, along which the station is located. The building will be 70 x 86 ft., one story high, with an additional half story at one end for transformer gallery, the type of construction being reinforced concrete. The electrical equipment will consist of two 1000-kw motor-generator sets, two banks of transformers of 3000 kw each for light and power service, eight arc regulators with a total capacity for 800 lamps and a switching station for a 10,000-volt feeder switch.

Fort Wayne & Northern Indiana Traction Company, Fort Wayne, Ind.—This company has purchased one 750-kw reversible frequency changer set from the General Electric Company.

Portland (Maine) Railroad.—This company has ordered three 500-kw motor-generator sets, two 1000-kw motor-generator sets and two switchboards from the General Electric Company.

Bay State Street Railway, Boston, Mass.—This company has purchased a 35-hp 2000-r.p.m. Terry steam turbine direct-connected to an Alberger four-stage 100-gal. per minute pump.

Twin City Rapid Transit Company, Minneapolis, Minn.—Plans are being made by this company to build a new substation in Minneapolis. The structure will be two stories, 47 ft. x 44 ft., and of brick construction. The cost will be about $10,000.

Brooklyn (N. Y.) Rapid Transit Company.—This company has awarded a contract for a 20,000-kva steam turbine to the Westinghouse Machine Company.

Manufactures and Supplies

ROLLING STOCK

Oshawa (Ont.) Railway lost five cars in a fire which destroyed its carhouse on March 29.

Norwich & Westerly Traction Company, Norwich, Conn., has ordered three cars from The J. G. Brill Company.

San Diego (Cal.) Electric Railway has ordered one 46-ft. construction car from the American Car Company.

Connecticut Valley Street Railway, Greenfield, Mass., has ordered ten cars from the Wason Manufacturing Company.

Wichita Falls (Tex.) Traction Company has ordered two 21-ft. 2-in. closed car bodies from the American Car Company.

Missouri & North Arkansas Railroad, St. Louis, Mo., has ordered two gas-electric motor cars from the General Electric Company.

Tarentum, Breckenridge & Butler Street Railway, Tarentum, Pa., is in the market for five 28-ft. single-truck second-hand car bodies.

East St. Louis, Columbia & Waterloo Railway, St. Louis, Mo., has ordered one 42-ft. 6-in. baggage and express car body from the American Car Company.

Frederick (Md.) Railroad has purchased a 22-ton electric locomotive from The J. G. Brill Company. It is equipped with four Westinghouse No. 101-K, 35-hp, 500-volt motors and HL control.

Oregon Electric Railway, Portland, Ore., has ordered two 50-ton electric locomotives and four 60-ton locomotives, each with four-motor equipments, for freight haulage from the General Electric Company.

Southern Pacific Railroad, San Francisco, Cal., has ordered twenty passenger cars from the Pullman Company and six direct-current 60-ton Baldwin-Westinghouse electric locomotives from the Westinghouse Electric & Manufacturing Company. The cars will have quadruple equipments of Westinghouse No. 327-C commutator pole, 50-hp motors and Westinghouse HL control.

British Columbia Electric Railway, Vancouver, B. C., has ordered twenty-four interurban cars from the St. Louis Car Company, of which twenty-two are intended for passenger service. They will be 50 ft. long and will seat sixty-four persons. The electrical equipment will consist of four 75-hp motors. The baggage cars will be 55 ft. in length and similar in construction to the cars now used for the purpose on the company's Fraser Valley branch.

TRADE NOTES

Wonham, Sanger & Bates, New York, N. Y., have received an order for seventy C. H. meters from the Madras (India) Tramway for installation on its cars.

Scully-Jones & Company, Chicago, Ill., have been made exclusive agents in Illinois, Indiana, Iowa and Wisconsin for Elco high-speed steel, made by Vickers Sons & Maxim, Sheffield, England.

McKeen Motor Car Company, Omaha, Neb., has opened an office in the Hudson Terminal Building, New York, N. Y., in charge of Stephen D. Barnett as Eastern representative. The company has just received an order from the Weatherford, Mineral Wells & Northwestern Railroad for two 70-ft. gasoline motor cars.

Eureka Company, North East, Pa., has succeeded the Eureka Tempered Copper Works and has increased its capital stock from $100,000 to $250,000. The personnel of the new corporation will remain the same as that of the one taken over. The established line of business will be continued and manufacturing facilities will be enlarged.

Kip Brush Company, New York, N. Y., announces that Harry M. Baxter is now in charge of its direct sales department. This department manufactures specially designed brushes for direct sale to contractors, railroads, etc. For several years past Mr. Baxter has been in charge of production and sales for the Wolfe Brush Company, Pittsburgh.

Rickard & Sloan, Inc., New York, N. Y., have been organized by William L. Rickard and Clifford A. Sloan with office at the Evening Post Building, New York, to conduct an advertising business. Particular attention will be given to the planning and management of advertising campaigns for companies engaged in the manufacture of mechanical and electrical apparatus and accessories.

W. J. Jeandron, New York, N. Y., American agent for Le Carbone carbon brushes, has appointed W. P. Poynton its sales engineer. Mr. Poynton was formerly with the motive power department of the Interborough Rapid Transit Company and for the past two years rotary-converter engineer with the New York erecting department of the Westinghouse Electric & Manufacturing Company.

International Oxygen Company, New York, N. Y., has installed an I. O. C. system oxy-hydrogen generating plant by the electrolytic process for the Navy Department at the Brooklyn Navy Yard. The capacity of the plant is 3500 cu. ft. of oxygen and 7000 cu. ft. of hydrogen per twenty-four hours. The navy yard previously generated its oxygen by a chemical method, but found this inadequate for its needs.

Nachod Signal Company, Philadelphia, Pa., has appointed Herman R. Stadelman its sales engineer. Mr. Stadelman entered railroad work with the Pennsylvania Railroad and was advanced to repairman at Jersey City. While there he became general foreman for the Federal Signal Company in charge of the installation of the signal system on the New York Central & Hudson River Railroad preparatory to and during the electrification. Later he was appointed signal supervisor on the New York, New Haven & Hartford Railroad east of Willimantic and New London.

Federal Storage Battery Car Company, Silver Lake, N. J., has completed a building, 150 ft. x 60 ft., in which it is installing a woodworking plant. The latest types of woodworking machinery for the finishing of car lumber have been selected. An extension to the truck and forge shop has also been built. A new building is about to be erected, which will be used as a paint shop. Charles R. Peterson, who was connected with the Brooklyn Rapid Transit Company for ten years and with the Metropolitan Street Railway, New York, N. Y., for the past several years, has joined the forces of the company as superintendent.

Walter A. Zelnicker Supply Company, St. Louis, Mo., recently celebrated the twenty-fifth anniversary of the founding of its business, which is devoted to the sale of new and used rails, locomotives, machinery and similar equipment. Since the founding of the original firm manufacturing businesses have been established under the name of the Zelnicker Car Works, East St. Louis, and the Zelnicker Crayon Works. These companies manufacture a number of specialties suited to street railway and interurban railway work, among them the Zelnicker portable wheel press and the Zelnicker sand dryer. H. J. Elson is assistant manager of the company and Edward Elson is traveling purchasing and sales agent for the company.

American General Engineering Company, New York, N. Y., announces that it has enlarged its quarters at 253 Broadway, New York, and opened a new department known as the "railroad department," which will be operated jointly by George E. Austin, president of the American General Engineering Company, and by John B. Given, in charge of sales. Mr. Given has been connected for several years with C. H. Wall & Company, Boston, and is well known in both steam railroad and electrical circles. The new department, which has already added several novel railway specialties, will devote its activities to the field outside of the metropolitan district, giving special attention to the needs of steam railroads which are in the early stages of electrification or which contemplate electrification.

Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa., has received the following orders for railway equipment: Public Service Railway, Newark, N. J., seventy-six quadruple equipments of No. 307-6A motors with type HL control; Cincinnati (Ohio) Traction Company, for four quadruple equipments of No. 303-A motors with type HL control; Orange County Traction Company, Newburgh, N. Y., for one double partial equipment of 101 B-2 motors; Bangor Railway & Electric Company, Bangor, Maine, for four double equipments of No. 306 motors with K-35-G control; Athol & Orange Street Railway, Greenfield, Mass.,

for ten quadruple equipments of 101 B-2 motors with double-end K-28-B controllers; Lehigh Valley Transit Company, Allentown, Pa., six quadruple equipments of No. 303-A motors with type HL control and four quadruple equipments of 101-B-2 motors and K-28-B control.

General Electric Company, Schenectady, N. Y., has received orders for railway equipment from the following companies: Eighty GE-210 70-hp two-motor car equipments, sixteen GE-214 75-hp four-motor car equipments and seven GE-205 100-hp four-motor car equipments for the Detroit United Railway, Detroit, Mich.; two 1000-kw rotary converters, two 1100-kva transformers, two 10,000-cu. ft. blower sets, one 300-kw two-unit, three-bearing motor-generator set, four 75-light, 13,200-volt mercury-arc rectifier sets and two 75-kw transformers for the Baltimore & Ohio Railroad, Baltimore, Md.; eight GE-203 50-hp four-motor car equipments and eight straight-air-brake equipments for Bucks County Electric Company, Newtown, Pa.; 520 single-end straight-air-brake equipments with CP-27 motor-driven compressors for the Philadelphia (Pa.) Rapid Transit Company; twenty-five GE-225 100-hp four-motor car equipments with GE type M control and twenty-five variable release automatic air-brake equipments for Kansas City, Clay County & St. Joseph Railway, Kansas City, Mo.; West Jersey & Seashore Railroad, Philadelphia, Pa., seven GE-212 225-hp two-motor equipments.

Union Switch & Signal Company, Swissvale, Pa., announces that the following changes in the sales organization of the company will go into effect on June 1: The Eastern division will be in charge of G. A. Blackmore as Eastern sales manager, with headquarters in New York, and will be subdivided into the eastern and southern districts. The Western division will be in charge of J. S. Hobson as Western sales manager, with headquarters in Chicago, and will be subdivided into the center district, in charge of Aaron Dean as resident manager, with headquarters in Chicago, and the Pacific district, in charge of J. B. Struble as resident manager, with headquarters in San Francisco, Cal. W. W. Vandersluis, now assistant Western manager, will become sales engineer for the Central district. H. W. Griffin, H. A. Wallace and T. H. Paternal will become sales engineers for the Eastern district, and J. L. Brastow will become sales engineer for the Southern district, with headquarters at Atlanta, Ga. At the adjourned meeting of the stockholders of the company, held on March 28, the proposed amendment of the by-laws, providing for an increase in the number of directors from seven to nine, was passed, and John R. McCune and W. D. Uptegraff were added to the board of directors.

Hall Signal Company, New York, N. Y., will be reorganized in accordance with a plan made public by the readjustment committee on April 2, 1912. It is proposed to form a new corporation, with $1,000,000 of 6 per cent twenty-year convertible debenture bonds, that may be called at par or made convertible into preferred stock, subject to the present $250,000 first mortgage of the company. There will be $2,000,000 of 7 per cent cumulative preferred stock and $3,000,000 of common stock. The debentures are to be called at the rate of $50,000 a year, beginning four years from the date of issue or earlier, and before any dividends may be paid in any given year on the preferred stock. Stockholders who deposited their stocks in the existing company will have the privilege of subscribing at par for the new preferred stock to the extent of 50 per cent of their holdings, and will receive a bonus in common stock, share for share, of their present holdings. The subscriptions are to be paid in five instalments of 20 per cent each at intervals of three months, and the committee offers to arrange a one-year loan on the third, fourth and fifth instalments. Of the $2,000,000 preferred stock $1,000,000 will be held in the treasury for the conversion of the debentures and the extra $1,000,000 of common stock will be used as a bonus for underwriting, expenses of reorganization, etc.

Prepayment Car Sales Company, New York, N. Y., reports the closing of numerous contracts for licenses and apparatus for prepayment cars since the first of the year, among which are the following: Boston Elevated Railway, license and door apparatus for 191 old cars to be converted to the pay-within type; Detroit United Railway, license for fifty new cars and twenty old cars converted to the pay-as-you-enter type; Capital Traction Company, Washington, D. C., license and door apparatus for conversion of thirty old cars to the pay-within type; Reading (Pa.) Transit Company, license and door apparatus for twenty new cars of the pay-as-you-enter type; Central Pennsylvania Traction Company, Harrisburg, Pa., license and door apparatus for six new cars and for five old cars to be converted, all of the pay-within type; United Railways & Electric Company, Baltimore, license for sixty new cars of the pay-as-you-enter type; Lehigh Valley Transit Company, Allentown, Pa., license and apparatus for four new cars of the pay-within type; Chicago, South Bend & Northern Indiana Railway, license and door apparatus for three cars to be converted to the pay-within type; Fitchburg & Leominster Street Railway, license for three new cars of the pay-as-you-enter type; Beaumont (Tex.) Traction Company, license and door apparatus for two new cars of the pay-within type.

ADVERTISING LITERATURE

Eugene Munsell & Company, New York, N. Y., are mailing price list No. 72 of electrical mica.

Universal Lubricating Company, Cleveland, Ohio, has issued a folder which describes the various grades of Tulc lubricant.

Ohmer Fare Register Company, Dayton, Ohio, has issued a circular which explains the operation of the Ohmer time feature registers for city service.

Chicago Pneumatic Tool Company, New York, N. Y., has issued catalog No. 40, which describes and illustrates the various types of Rockford railway motor cars.

General Electric Company, Schenectady, N. Y., has issued Bulletin No. 4940, which illustrates and describes its latest development of the commutating pole motor known as type DLC.

Colorado Ingot Iron Pipe & Culvert Company, Colorado Springs, Col., has issued a 24-page catalog on American ingot iron corrugated culverts. The publication discusses the merits of the culvert and illustrates many service tests.

Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa., has issued Leaflet No. 2440, which describes the Westinghouse split-frame commutating pole railway motor 323-A. This motor has a rating of 32 hp at 500 volts and 38 hp at 600 volts.

Terry Steam Turbine Company, New York, N. Y., has issued an illustrated booklet entitled "Terry Service" which shows the wide range of uses of Terry turbines now installed in all parts of the world, driving generators, pumps, forced draft and gas blowers, etc. The catalog also gives the names of prominent installations.

Brown Hoisting Machinery Company, Cleveland, Ohio, has issued Pamphlet S, which describes fully the Brown-hoist patent suspended bin, giving details of its construction and showing a few installations of the bin. Several Brown-hoist machines which work in connection with the suspended bin in power plant installations are also illustrated.

Watson-Stillman Company, New York, N. Y., has just issued Catalog No. 85 on hydro-pneumatic wheel presses. The catalog describes and lists the company's full line of hydro-pneumatic wheel presses and those with hydro-pneumatic pull-back only. Seventy-six types and sizes, on which the Watson-Stillman Company has exclusive patents, are listed.

Texas Company, New York, N. Y., has issued a handbook of 150 pages, bound in cloth, on the engineering features of the use of oil fuel. It includes chapters on the design, construction and management of oil furnaces and burners for use under steam boilers and for metallurgical processes. Detailed results of a large number of boiler tests in stationary, marine and locomotive service are given, as well as a discussion on the general subject of the determination of the comparative value of oil and coal as a fuel for steam boilers under various conditions. The book concludes with a number of rules and descriptions relative to engineering units and methods of testing. The whole work is liberally illustrated and supplied with tables showing equivalents and standards applicable to the subject in hand.